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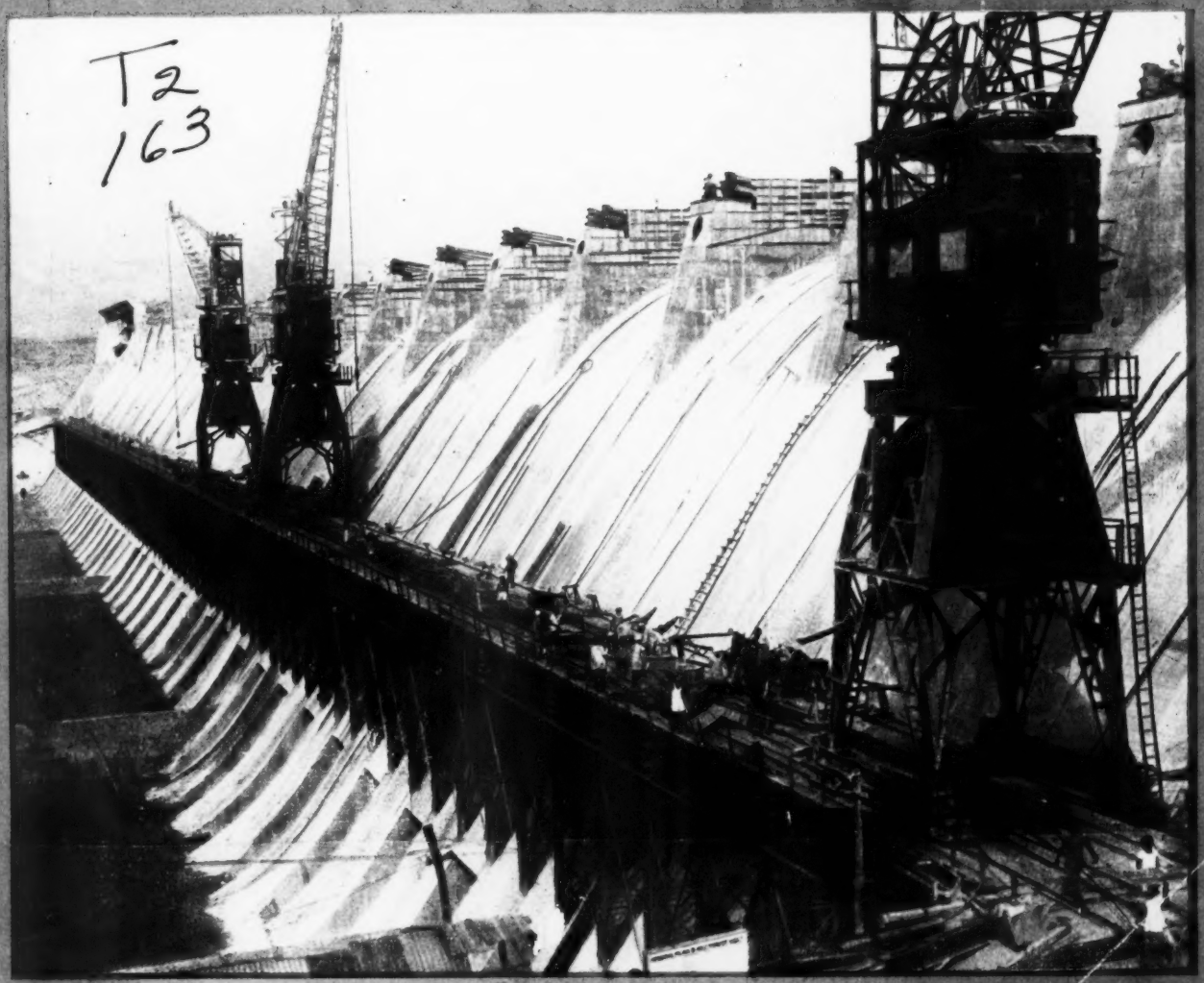

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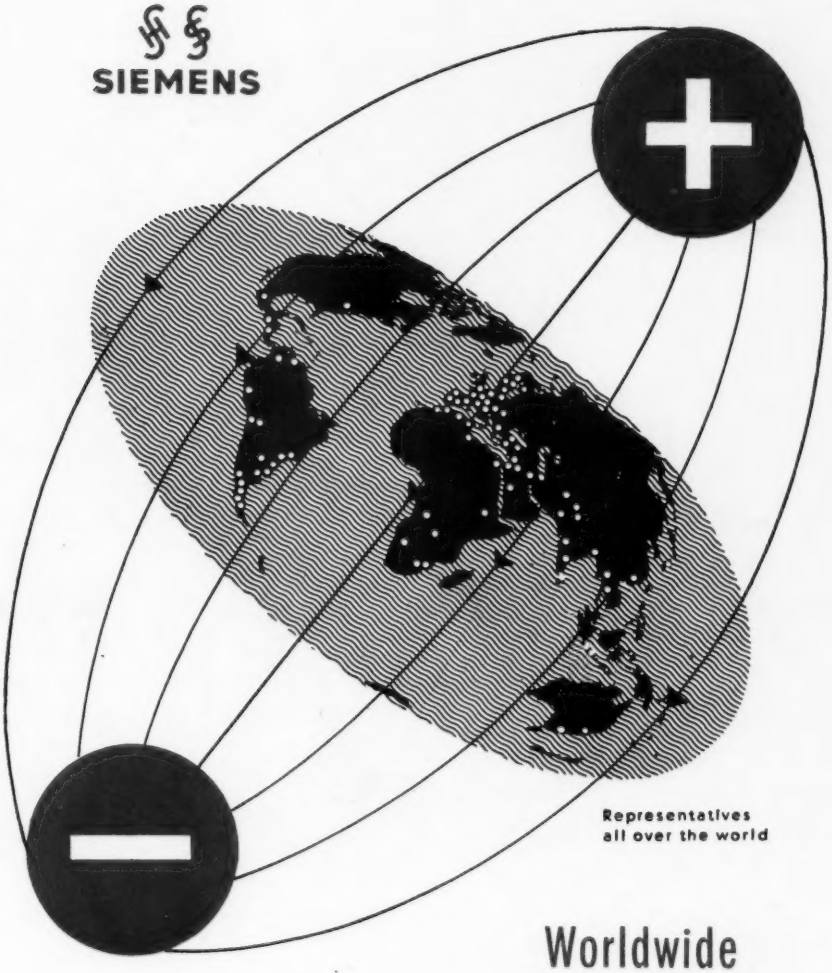

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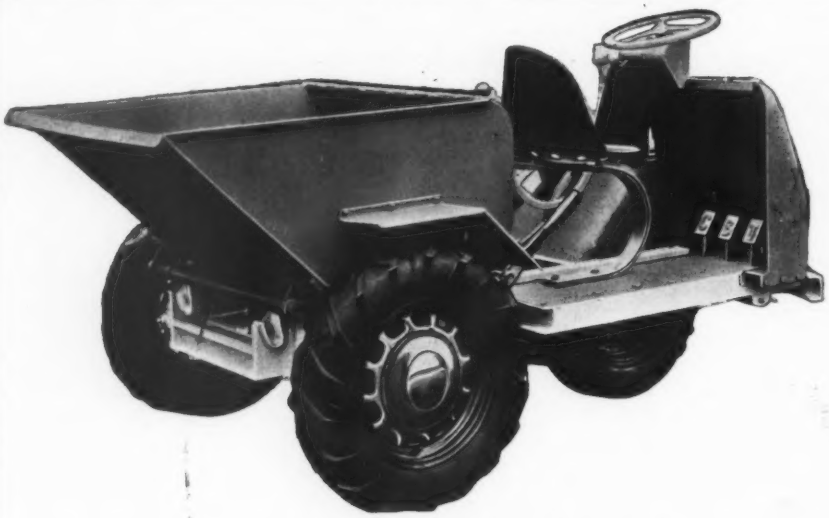

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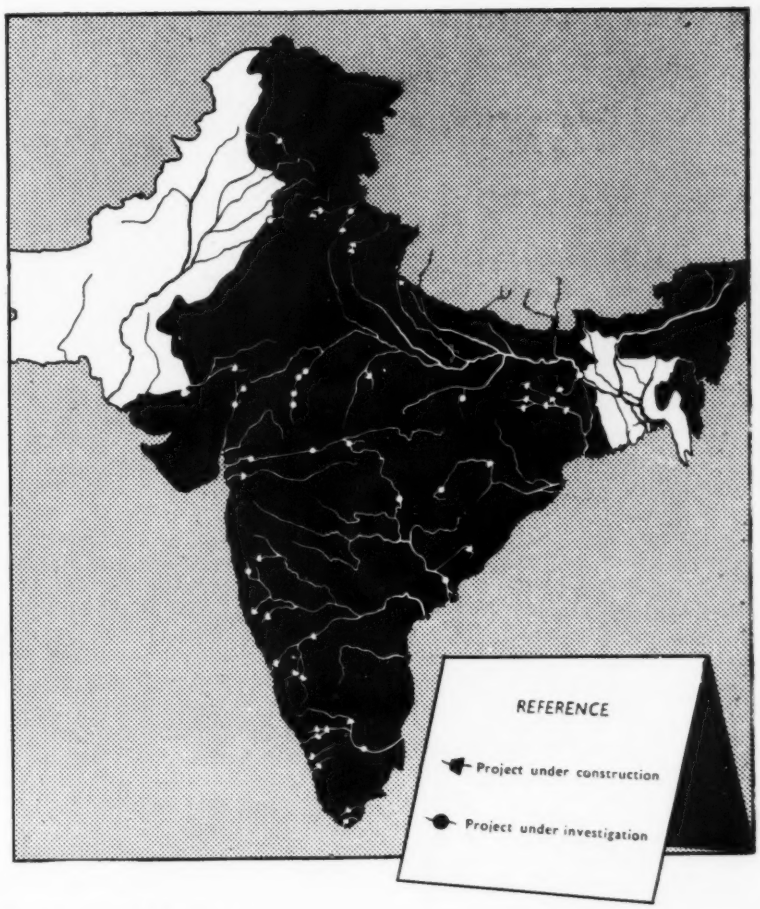

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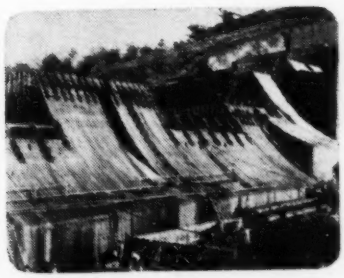

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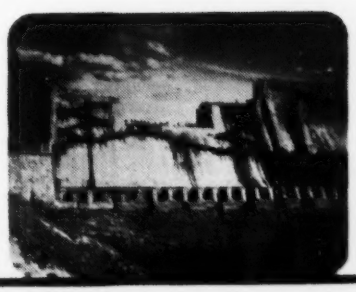

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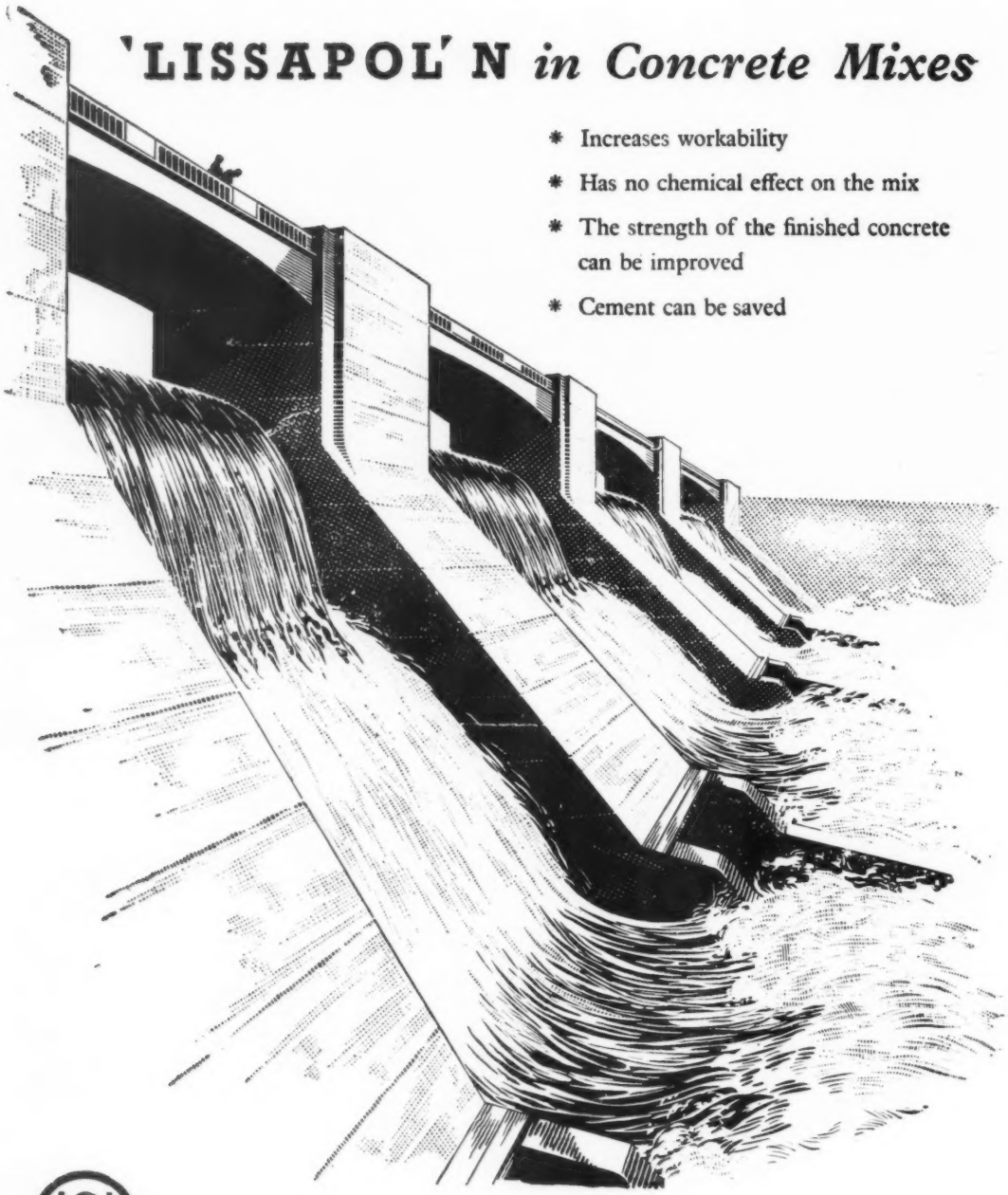

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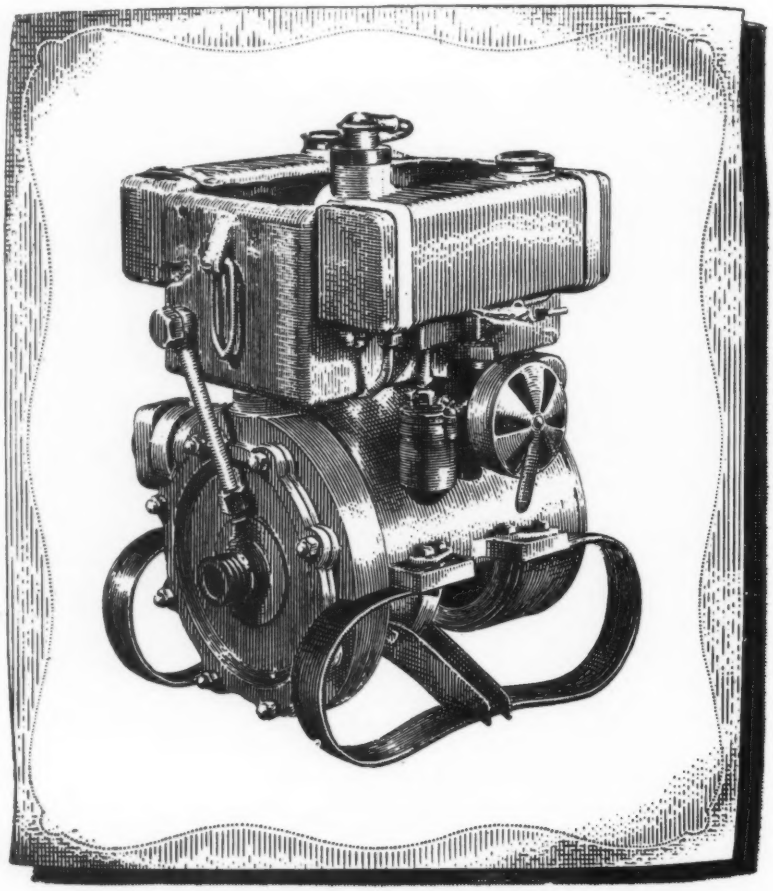

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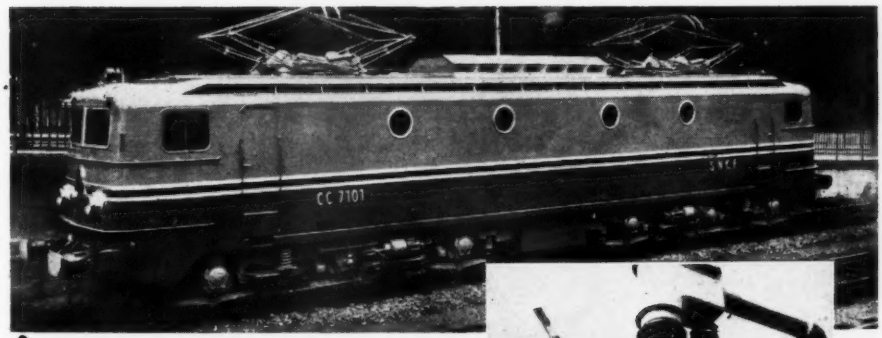
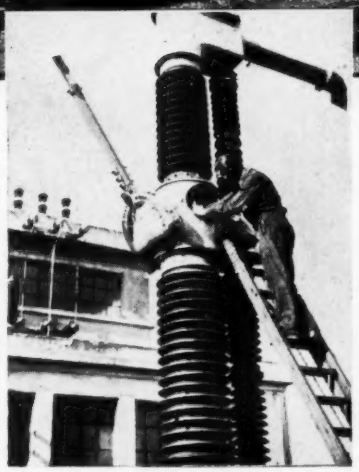


↑ALSTHOM – Electric locomotive type CC, 4,800 HP, 1,500 volts DC. Maximum speed 112 miles per hour. Weight 106 tons.

↓NEYRPIC – Thrust bearing for Monsin Power Station, Belgium, during machining and assembly.



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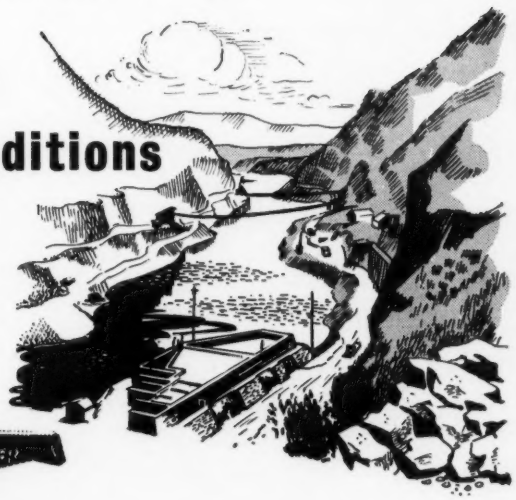

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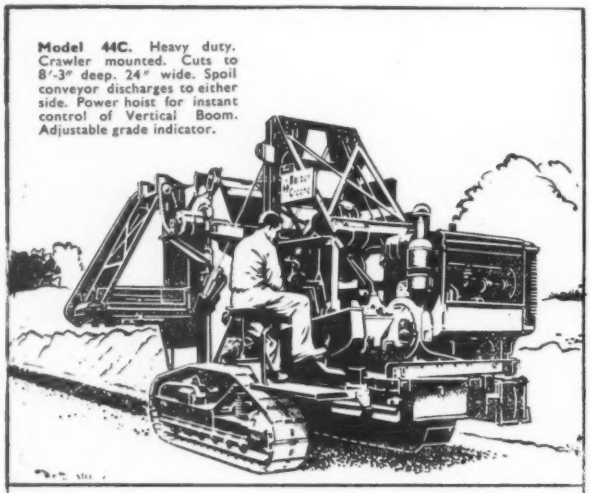

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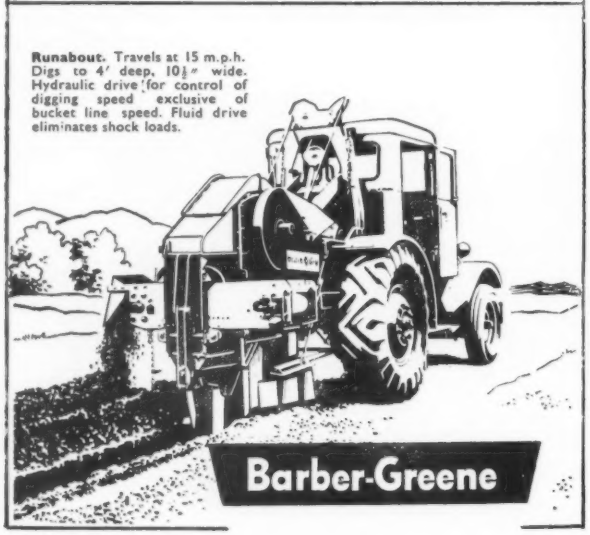

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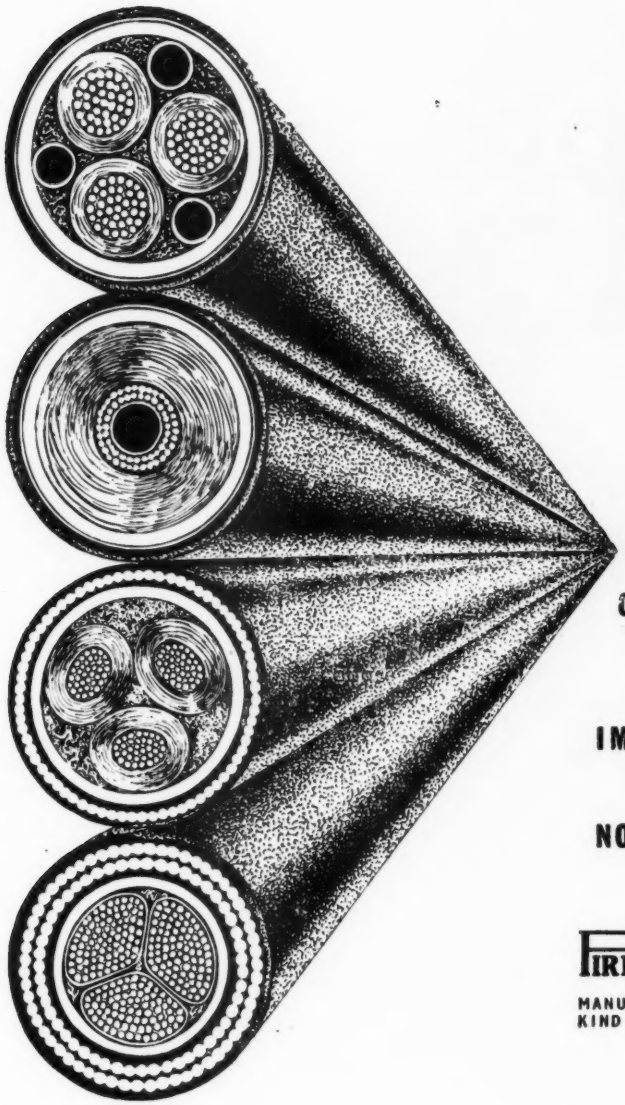

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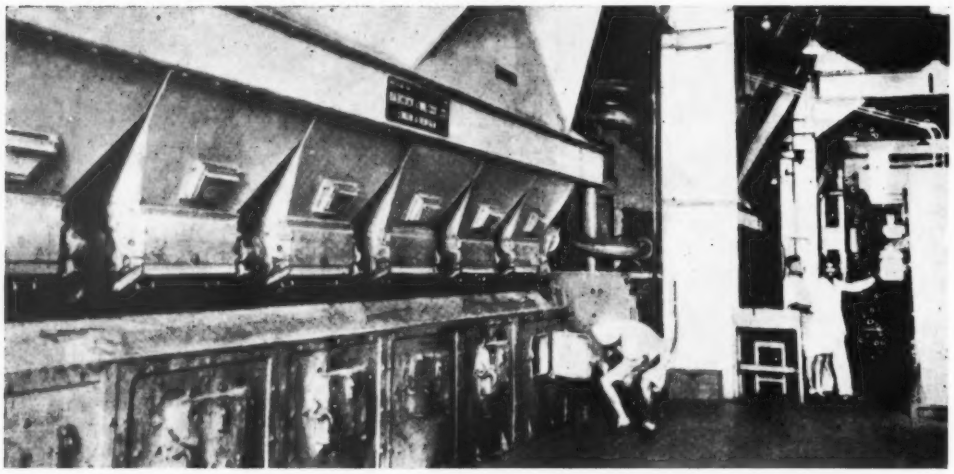

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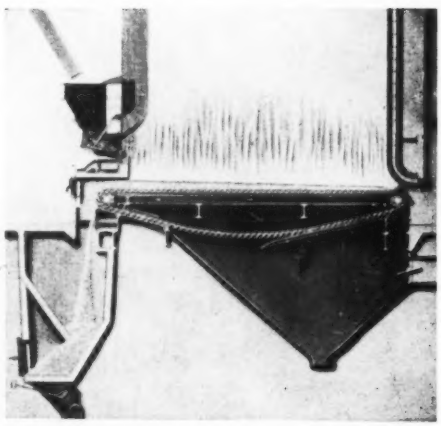

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A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA

Editor : **K. K. Sinha** — **P. K. Menon** : Mg. Editor

Vol. V — May 1955 — No. 5

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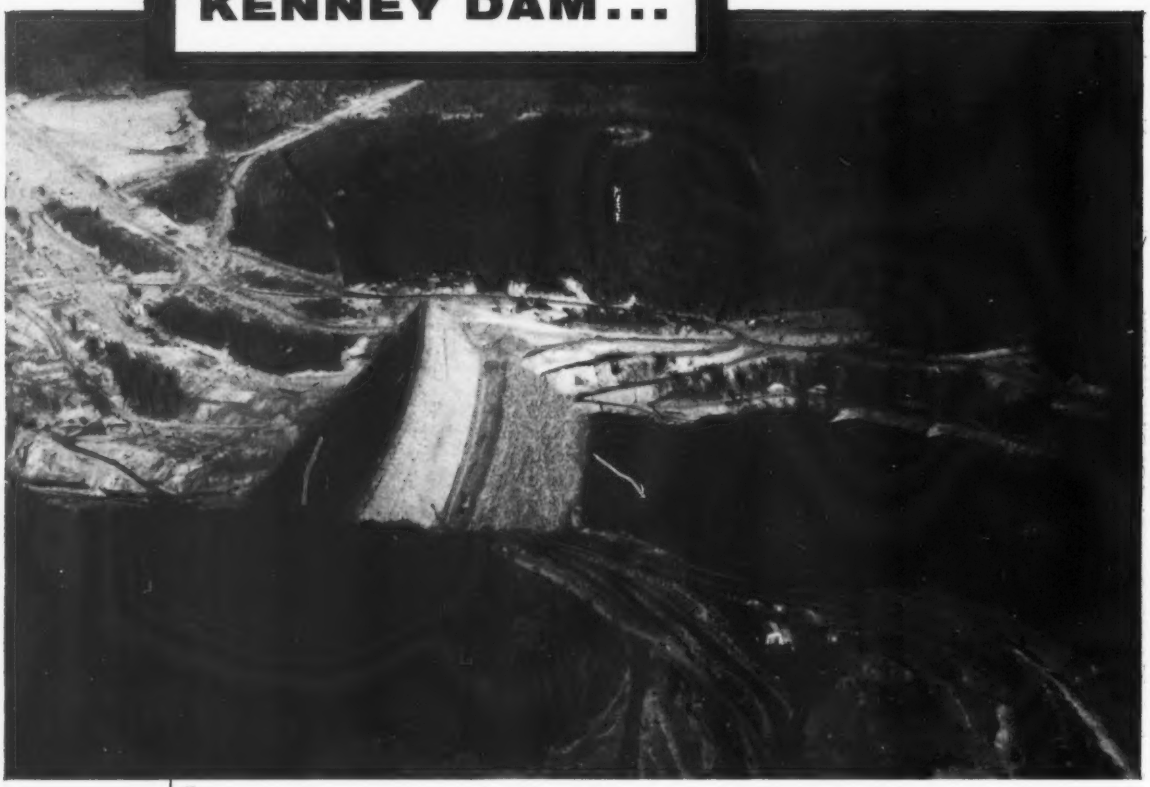
KENNEY DAM...



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The Hydro-Electric Industry

CHARLES JAEGER

Dr. Jaeger is welknown as an authority on Hydro-electric engineering. In this contribution which is based on a lecture delivered by him at the Centre de Recherches Industrelles in Geneva in March 1954, he surveys admirably the whole field of Hydro-electric industry in modern times in the context of recent developments in the fields of atomic energy and tidal power. In discussing the administrative aspects of the industry, he points out that whether the industry is State-owned or privately-owned, its success is primarily dependent on the technical ability of the staff. The author expects that within the next 10 to 15 years the world's water power would be doubled or trebled and with this the demographic pattern will be considerably affected. He therefore pleads for bold planning and designing and greater coordination between all sections of the social organism involved.

AUTHOR

Electric power can be obtained by using the energy of steam or by transforming the energy of flowing water. In this article the hydro-power side of the electrical industry will mainly be considered. The aim of the Hydro-power Industry is to produce, transmit and distribute electric energy, generated from hydraulic energy, in order to meet growing demand from the consumers.

The exploitation of hydro-power will depend largely on natural conditions of climate, rainfall, availability of water all the year round and on the existence of a head or difference between the water levels upstream and downstream of a practicable site for the turbines. The cost of hydro-power will depend also on the geological conditions, which the civil engineers have to consider carefully when designing and planning the construction.

Hydro-power depends to a large extent on existing demographic conditions. It may happen that the water-power potential occurs in densely populated areas, as in the Rhine Valley between Basle and Strassbourg or on the Rhone between Geneva and Donzere. More recently, hydro-power generated in poorly populated areas like the Italian, French or Swiss Alps, in the east and north-eastern parts of Canada, or in the far north of Sweden, has to be transmitted hundreds of miles to the more densely populated and industrialised areas. Another unexpected aspect of the later development of hydro-power resources is its force of appeal for new immigration. At a very early stage, the first hydro-power developments in the French Dauphiné contributed to the demographical and industrial development of this French province. More recently, the development of hydro-power in the Tennessee Valley and in the north-west of the United States has caused migration towards these provinces. One of the main objects of the North of Scotland Hydro-Electric Board is to make electrical energy available to the northern parts of Scotland, to encourage new local industries and to counteract the trend towards depopulation which has menaced the northern counties for more than a century. All these aspects affecting the production, the transmission and the distribution of hydro-electric energy will have to be considered.

Charles Jaeger, Dr. es Sc. tech., *Consulting Engineer to the Hydraulic Department of The English Electric Company, and Special Lecturer at the Imperial College of Science and Technology, London.*

Early Development of Hydro-Power

In France, Aristide Bergés (1833-1904) is accepted as one of the pioneers of hydro-power. In 1869 he equipped the first hydro-power station with a head of 200 metres, an extremely high head for that time. The power produced, about 3.4 h.p., was not electrical but was used directly as mechanical power in a paper mill. A few years before (1867), the first dynamo-machines had been built by Siemens and by Wheatstone. By 1889, that is over a period of twenty years, Aristide Berges had equipped 17,000 h.p. of plant in the Dauphiné around Grenoble. Meanwhile, Hippolyte Fontaine had improved the Gramme machine, and Marcel Deprez realised the first long distance transmission of energy in 1881 at the Paris International Exhibition and again in 1882 at the Exhibition at Munchen, Germany. In 1883, 7 h.p. was transmitted over a distance of 14 km at Grenoble with an efficiency of 62%. In September 1882, Thomas Edison put into service the first electric generating plant in New York, the generator being driven by steam. A few days later, a generator driven by water power began operation at Appleton, U.S.A. In the year 1885, C. E. L. Brown, founder of the firm Brown Boveri, then at Oerlikon, transmitted 50 h.p. at 1,250 V over a length of 8 km with an efficiency factor of 75%. The first American example of long distance transmission was in 1889 between Oregon and Portland (450 kW over 13 miles at 400 V). This was the signal for the first considerable hydro-power developments in Europe, and also very soon in the United States.

In the years 1882 to 1885 the first manufacturers of electrical machinery started their creative work in both continents. The year 1884 was of great imporance for the introduction of alternating-current machinery which provided the foundation for the electrical industry.

The first hydro-electric power stations were designed and built about 1890, that at Chevres, near Geneva, being dated 1896.

Basic Technical Aspects of Hydro-Power Production

The object of the hydro-power industry is to produce electricity by utilising the energy of falling water. A hydraulic machine or turbine will produce a power N by using a discharge Q over a head H, or better, a net head H_1. The general formula which applies is

$$N = w\eta\ QH_1$$

where 'w' is the specific weight of the water, and 'η' is an efficiency factor indicating how much electrical energy can be recovered from the hydraulic energy ; the quantity $(1-\eta)QH_1$ represents the losses in the turbine and generator.

In this formula all the quantities are in metres and kilograms per second, or in feet and pounds per second. The usual unit of power is the horsepower (h.p.), the normal electrical unit is the kilowatt (kW) and a power of 1 kW used during one hour represents a unit quantity of energy or 1 kWh. There are conversion factors to transform kilogram-metres or foot-pounds into h.p. or into kW.

The usual method of developing hydro-power is to dam a river and divert the water over a system of open canals or pressure conduits and pipe lines to a power house, where turbines absorb the discharge Q under a pressure head H, thus producing a power N. The water returns to the river through a tail-race canal.

According to the head available, engineers distinguish :—

(*a*) High head power stations equipped with impulse or Pelton wheels ;
(*b*) Medium head power stations equipped with reaction or Francis turbines ;
(*c*) Low head power stations equipped with feathering propeller or Kaplan turbines.

The basic principles are always the same. If the topographical conditions are favourable, the length of the head-race canals or pressure conduits may be reduced. There are power stations without head-race canal or conduit, and without any tail-race. A typical case is that of a larger river being crossed by a dam or weir into which a power station is built. The water is held back by the weir or dam, thus creating the necessary head for the turbines.

The discharge of a river depends on the rainfall, or sometimes on the melting of snow or ice. The discharge varies widely with the season, and the ratio of flood water to low water can be greater than a hundred to one. On the other hand, the demand for hydro-power is fairly constant all the year round, with possibly a slightly greater demand during the winter than during the summer. One of the main problems the hydro-power industry has to solve is the adjustment of the production of the energy to be actual demand. Plants where no storage of water is possible and producing seasonal energy only are called 'run of the river' stations. The aim is to produce firm power, and different means have been worked out for spreading the production of electricity more evenly over the year, by :—

(*a*) creating large reservoirs where water is stored for the dry season ;
(*b*) diverting water from one catchment area to another ;
(*c*) combining 'run of river' plants with large storage plants (the Tignes reservoir will work in series with Isère Arc, Mauvoisin and Grande Dixence storage in parallel with seasonal power plants on the Rhine—see also the Tennessee Valley Authority's system) ;
(*d*) using excess energy produced during the wet period, or at night, to pump water into storage reservoirs (so-called pumped storage plants) ;
(*e*) combining 'run of the river' plants with pumped storage schemes (Kembs on the Rhine, and the Lac Blanc-Lac Noir pumped storage scheme) ;
(*f*) combining two different 'grids' (the French Alpine hydro-power system with the group of power stations in the Massif Central) ;
(*g*) combining hydro power with steam power (in France, half of the production is hydro power and half steam power) ;

Finally, we must not forget the possibility of developing tidal power, where this power which varies over the day with the tide could be absorbed by a very large 'grid'.

Administrative Organisation of the Hydro-Electric Industry

Private enterprise started the whole electrical industry, and private initiative also founded the hydro-power industry. In a paper on the early development of the hydro-power industry in Switzerland, the author underlined the fact that in Switzerland private initiative has always done the pioneering work. The same economical process has also obtained in other countries.

Very soon, cities and counties began developing their own hydro-power stations to meet the increasing demand for this latest form of energy. From the earliest stages, state-owned enterprises became competitors with private concerns.

If to-day we consider more generally the hydro-power industry from the angle of production and distribution of electricity, we find a wide variety of administrative arrangements. In some countries, the industry for the most part is privately owned. This is the case in Italy where private companies (like the Edison Group, the Societa Adriatica di Elettricita, and the Montecatini Group) are responsible for the bulk of the national energy production, and are far

more powerful than public corporations like the Electricity Board of Milan.

The opposite course was taken in France where, since 1946, the entire electric power industry has been nationalised. Two powerful State-owned corporations govern the whole business of electricity production and distribution. The Compagnie Nationale du Rhone (Authorised by the law of 1921, but established only in 1933) is in charge of power development in the Rhone valley, including irrigation and navigation on the Rhone river. The rest of the country is provided with energy by Electricite de France who took over from private industry after the end of the last war. The arguments in favour of nationalisation of the French power industry, as a counterpart of the nationalisation of the French railways and coalmines, were mainly technical and financial. It is alleged that French private industry would not have been able to raise the money and provide the technical and specialised staff which was required to face the heavy burden of post-war development, as outlined by the well-known Plan Monnet.

Problems of finance are outside the scope of this article. Concerning the technical staff of Electricite de France, this corporation inherited all the staff from the concerns which were nationalised and it is likely that, at the beginning of its activity, Electricite de France was rather overstaffed.

The practical achievements of Electricite de France in the last seven years are considerable. At the peak of the development programme in the year 1950, Electricite de France had accomplished in 10 months the movement of 840,000 m^3 of earth and the placing of 1,260,000 m^3 of concrete. In 1949, this authority excavated 84 km of tunnel. It is possible that many internal changes in French private industry would have been necessary to enable it to face such a construction programme.

The Swiss hydro-power industry is characterised by a high degree of collaboration between private and state-owned enterprises, thus demonstrating what can be achieved when nationalisation is rejected by public opinion but a high degree of control by the state is nevertheless considered desirable.

There are four types of state-owned electricity corporations in Switzerland :—

(1) Electricity boards entirely in the hands of one township, like Zurich or Basle.
(2) Electricity boards directed by a cantonal authority such as the Bernische Kraftwerke (a canton being the equivalent of an English county). Examples are the Electricity Boards of the Canton of Berne and of the Canton of Fribourg.
(3) The powerful Nord-Ost Schweizerische Kraftwerke (N.O.K.) is a corporation grouping several cantons in the north-east part of Switzerland. This N.O.K. group, in spite of being entirely state-owned, has the legal status of a private company, all the shares being in the hands of the cantons. A large amount of private money is invested in the N.O.K. corporation as debenture loans.
(4) Finally, the Swiss Federal Railways are the owners of a series of powerful stations in different parts of the country.

Associated with these public corporations, there are different types of private electricity companies. The powerful Aare-Tessin which transmits power in the north-south direction over the Swiss Alps is one of them. The aluminium industry and some chemical companies are also owners of large hydro-power stations. Several companies with the legal status of a private company are really state owned, all the shares being in the hands of cantons or townships (*e.g.* Oberhasliwerke).

To understand how the whole industry works and expands, it is essential to mention the activities of the technical banks, by far the more important of these being Electro Watt (former Banque pour Enterprises Electriques, Zurich) and Motor Columbus.

The Limited Company Motor was founded in 1895 by Walter Boveri, the founder of Brown Boveri and Co. (1891). This firm was responsible for the design and construction of many of the earliest hydro-power stations in Switzerland. Most of these stations were transferred to private or publicly owned power companies, including the Kraftwerke Beznau-Lontsch (1907) and the Officine Elettriche Ticinesi (1917). In 1911 it helped to create the Compania Italo-Argentina de Electricidad in Buenos Aires. After World War I, 'Motor' suffered considerably owing to the post-war currency trouble, which struck its foreign assets, and in 1923 it merged with a subsidiary, the financial trust called Columbus (created in 1913). They had a joint capital of 60,000,000 Swiss francs which was later increased to 93,000,000 frs but went down to 55,250,000 frs in 1938 as a consequence of the economic crisis. To-day, the capital is back to 60,000,000 frs. To alleviate the balance sheet, the debentures were reduced successively from 82,000,000 to 37,000,000 francs during the years 1938 to 1945. Since this re-organising, Motor Columbus has been engaged successfully on consulting engineering work and in studying, organising, partly financing and launching a series of large hydro-power schemes. It was responsible for :—

Ryburg Schworstadt on the Rhine (1929-31), 108,000 kW ;
Piottino on the Ticino (1931) ;
the first power transmission line in the south-north direction over the Gotthard Pass (1933) ;
Lucendro near the Gotthard Pass (1945-47), 48,000 kW.

To-day Motor Columbus is participating actively in the development of the enormous Grande Dixence Scheme.

The story of Electro Watt, former Banque pour Enterprises Electriques, is very similar. This group was founded as a technical bank with the purpose of financing hydro-power projects directly, or of helping the promotors in raising the necessary capital.

The two World Wars and the economic crisis between the wars were highly detrimental to Electro Watt, owing partly to its extended assets in foreign countries. Since the end of World War II, the firm has been active again and is now concerned with the recent developments of the powerful Mauvoisin scheme.

In the period following the end of the war in 1945, both groups have fully recovered financially. They are now concentrating on acting as technical and financial advisers to large power schemes inside Switzerland. Recently, both groups resumed a limited activity on the international market also.

The picture of the Swiss hydro-power industry past and present would not be understandable without a clear description of how these two groups work, being strong competitors one to the other, but collaborating intimately with private and with public producers of hydro-electricity. From the financial side their activity is of great importance, as it backs and maintains the independence of private industry and gives powerful backing to the Swiss Stock Exchange and to private capital which finds in the hydro-power industry a desirable opening for large investments.

This section on the administrative aspects of the hydro-power industry may be summarised as follows :—

Private initiative started the whole hydro-power industry and in several countries still holds the whole industry firmly in its hands, or shares its control with state-owned and state-controlled bodies.

The nationalisation of the hydro-power industry, or in more general terms the electric power industry, occurred very largely

(*a*) when a nation had to develop its hydro power rapidly with little previous experience (*e.g.* India), or

(*b*) when difficult economic conditions urgently required standardisation of existing industries and their rapid extension. These were the conditions which forced nationalisation upon the British and the French electrical industries immediately after World War II.

It is increasingly important to entrust to trained engineers the administrative and management responsibilities at a high level, if the hydro-power industry is to be prosperous. The financial success of the industry depends to a large extent on the technical ability of the staff, and this aspect is worthy of further discussion concerning the technical staff, their training and technical ability, and the relations of the hydro-power industry with its technical consultants.

The Present Production of Hydro-Power in relation to Main Sources of Energy

The production of hydro-power in the world compared with the world production from other main power sources is best shown in a series of tables. The first (Table I) refers to the world power production between 1913-1952.

TABLE I

World Production of Power from the Main Sources of Supply

Year	Coal and Lignite, millions of metric tons	Crude Petroleum, millions of metric tons	Natural Gas, 1,000 mliions of cubic metres	Electric Power 1,000 million kWh	
				Total	Hydro
1913	1,256.1	53.7	18.1	—	40
1938	1,300.5	280.7	78.5	460.6	172.9
1946	1,290.9	376.8	132.4	644.0	232.0
1950	1,551.3	524	212.2	951.4	332.7
1951	1,640.3	592	239.7	1,060.5	368
1952	1,608.3	618.1	284.2	1,134.0	397.0

For comparison, these figures have been translated into coal equivalent measured in millions of metric tons in Table II, and are shown graphically in Fig. 1.

TABLE II

World Production of Power from the Main Sources, given in Coal Equivalent in millions of metric tons

Year	Coal and Lignite	Crude Petroleum	Natural Gas	Hydro-electric	Total
1913	1,256.1	80.1	27.0	32.0	1,395.2
1938	1,300.5	418.9	117.2	138.3	1,974.9
1940	1,290.9	562.4	197.6	185.6	2,236.5
1950	1,551.3	782.1	316.7	266.2	2,916.3
1951	1,640.3	877.1	358.9	294.5	3,169.8
1952	1,608.3	922.5	425.4	317.1	3,273.3
			in percentages		
1938	65.9	21.2	5.9	7	100
1952	49.1	28.2	13.0	9.7	100

Based on these figures, it is possible to calculate the annual rate of increase in the world production of power, as given in Table III and Fig. 2.

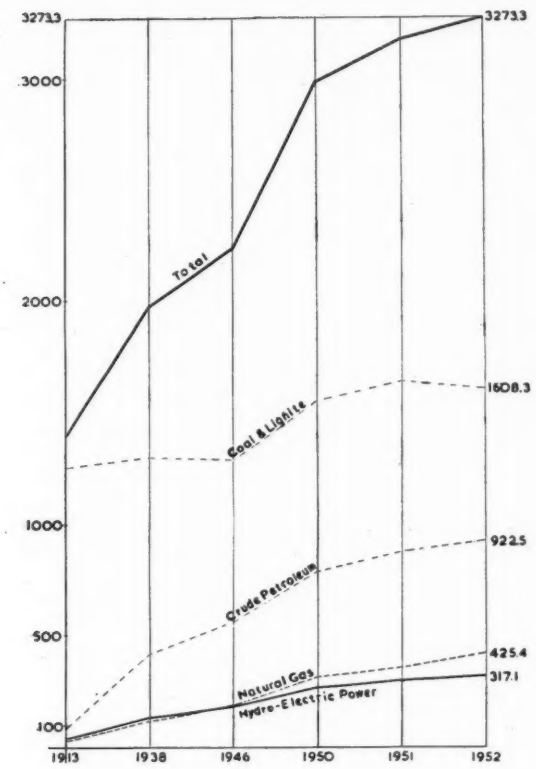

Fig. 1—World production from the main power sources in coal equivalent in millions of metric tons (1913-1952)

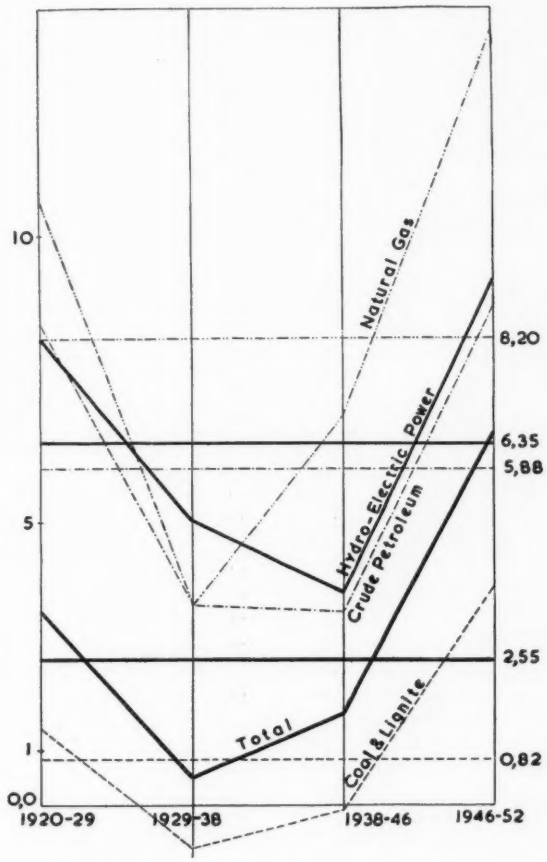

Fig. 2.—Percentage annual rate of increase in the world's power production (1920-1952)

TABLE III

Annual Rate of Increase in the World Production of Power

Period	Coal and Lignite	Crude Petroleum	Natural Gas	Hydro-electric	Total
	%	%	%	%	%
1929-1938	-0·75	3·50	3·50	5·50	0·50
1938-1946	-0·10	3·38	6·75	3·75	1·60
1946-1952	3·75	8·60	13·60	9·30	6·56
1920-1952	0·82	5·88	8·20	6·35	2·55

For the period 1938-1952, the average annual rate of increase in the production of electricity has been as follows (Table IV).

TABLE IV

COUNTRIES	%	
Austria	.. 7·3	
France	.. 5·7	
West Germany	.. 17.1 (1947-52)	
East Germany	.. 9.6 (1947-52)	
United Kingdom	.. 7.1	
Italy	.. 5.1	
Norway	.. 4·7	
Portugal	.. 8.6	
Spain	.. 8.4	
Sweden	.. 6.9	
Switzerland	.. 4·5	
Europe	.. 4.8	(without U.S.S.R.)
U.S.S.R.	.. 8.0	(1921-38)
U.S.A.	.. 8.6	
Canada	.. 6.3	
Mexico	.. 5·7	
Argentina	.. 5.2	

Brazil	.. 7·5
Chile	.. 9·9
Columbia	.. 10.3
Venezuela	.. 14·5
India	.. 8·7
Australia	.. 7·3
New Zealand	.. 6.8

The present trend of power increase is in most countries even more energetic.

In the year 1952, the production of hydro electricity on the different continents was as follows (Table V).

TABLE V

Production of Hydro-electric Power in 1,000 millions of kWh for the Year 1952

Europe	.. 136
U.S.S.R.	.. 13
Asia	.. 52.5
Africa	.. 1.8
North America	.. 175
South America	.. 13
Australia	.. 5·7
TOTAL	.. 397.0

This is out of a total of $1{,}137 \times 10^9$ kWh, including thermal energy, for the same year 1952.

The production of hydro-electric power for the more important countries has been as in Table VI.

TABLE VI

Total Production and Hydro-electric Production of Power for the Year 1952 in 1,000 millions of kWh

Countries	*Hydro*	*Total*
Austria ..	6.36	8.02
France ..	22.45	40.8
West Germany ..	9.946	56.2
East Germany ..	—	21.7
United Kingdom ..	1.27	61.99
Italy ..	27.1	30.84
Norway ..	18.67	18.77
Portugal ..	1.2	1.33
Spain ..	6.95	8.45
Sweden ..	19.5	20.7
Switzerland ..	13.0	13.1
U.S.A. ..	109.6	462.6
Canada ..	59.5	61.7
Mexico ..	—	5·3
Argentina ..	—	4·7
Brazil ..	—	3.08
South Africa ..	—	12.5
Japan ..	40.7	50.88
Turkey ..	—	1.07
Australia ..	5·7	11.7
New Zealand ..	3·4	3·5
U.S.S.R. ..	—	11.70

For the foregoing figures the sources of information are the publications of the United Nations Organisation and the U.N. Economic Committee for Europe. The Italian paper Quaderni, Volume 9, No. 147, May 1953, was also consulted.[2]

Assessment of the Water Power available

Having described the present utilisation of hydro power as compared with other sources of energy all over the world, and having ascertained the general trend of this utilisation, the interest may be shifted to the future of the hydro-power industry. There must be somewhere a limit to the possible development of water power, depending on natural conditions of climate, rainfall, the gradient of the rivers, etc. The next step in this enquiry will be to assess the hydro-power available and to compare the present output with the potential output.

Estimation of the available water power is now-a-days considered a matter of national importance and in most countries it is done on a national basis, even in those countries where the production of hydro electricity is not nationalised. Very recently, the Economic Commission for Europe Committee on Electric Power of the United Nations published an extensive report on 'Hydro-electric Potential in Europe and its Gross Technical and Economic Limits' (Geneva 1953). This report will prove most valuable when estimating possible transfers of energy from one country to another on the European Continent. The enquiry revealed that there are some economic or physical constant values which can be transferred from one area to another, from one country to another. The report claims that the knowledge of these constants, as obtained by a detailed analysis of the conditions in countries where the hydro-power industry has reached a high level of development, may be of great assistance to authorities charged with assessing the water power available in under-developed or newly prospected countries.

In the introduction to the Report we are told that "it is possible to assess the water-power resources of different regions on a consistent basis if three alternative levels of definition can be used. These levels may be stated as follows :—

(*a*) The gross potential power of the head and flow of water physically available in an average year.

(*b*) The proportion of this latent power which it is technically possible to harness at a given time.

(*c*) The proportion which can be exploited economically at a given time."

The importance of introducing these clear definitions is best shown by Table VII, an official estimate of hydro resources in Switzerland, which shows how

[2] *See also F. Bolens, Bulletin Technique Suisse Romande, Vol. 79, No. 11-12, June 13, 1953.*

TABLE VII

Official Estimates of Hydro Resources in Switzerland (1898-1946)

Year	Q95*	Q50*	Arithmetic mean flow	Mean annual production possibilities	Actual annual production	Col. 6 as percentage of col. 5
	MW	MW	MW	10^6 kWh	10^6 kWh	%
1	2	3	4	5	6	7
1898		470		4,500		
1914	660	1,880		15,000	1,300	9
1934	2,400	3,800	5,100	20,000	5,312	27
1946	3,300	5,200	7,000	27,000	10,060	37

* *The flow available for 95% and 50% of the time*

the estimates may vary when knowledge of the physical and climatological data involved becomes greater.

Trends in assessment and exploitation such as demonstrated in this table are common to practically all countries possessing hydro resources in a relatively advanced stage of development. They have arisen, first, from improvements in the assessment of physical features of sites, from accumulation of fuller and more reliable records of precipitation and run-off, and from more complete topographic surveys. Next, the conception of what is technically possible within acceptable limits has been widened enormously in recent years, thus causing ever greater demand for accurate surveys. During the last 30 years, various technical advances have, in practice, largely sufficed to cancel but the opposing tendency for real costs to rise parallel to rises in wages and salaries.

Wide variation in the estimates of available hydropower made it necessary to give clear definitions of the gross, the technical and the economic possibilities.

The yearly gross hydro-electric potential is given by the expressions

$$\frac{1,000}{75} Qh.0.736 = 9.81QhkW, \text{ or}$$

$$8,584QhkWh$$

assuming that the generating stations run during the 8,760 hours of the year,
where Q = arithmetic mean over a period of years of the yearly average natural flows (m /sec) at the mid-point of the section of the water course considered, and h = gross head in metres, *i.e.* difference in level between the ends of the section considered.

The basic formula then gives the maximum yearly potential for a given flow through a given difference of level : it assumes :—

Complete equalisation of seasonal flow ;
complete utilisation of the head ;
100 per cent plant efficiency ;
100 per cent utilisation of the energy.

Methods have been developed in France, Italy and Switzerland for assessing correctly the mean flow Q and for integrating correctly the values Qh over large areas. The Electric Power Division of the Economic Commission for Europe has developed its own method, which has been compared with others. The estimation of the gross power is a difficult problem in countries where accurate data on the hydrology of the main rivers have not been accumulated over long periods of years. It is a far more formidable task in underdeveloped countries or newly prospected countries where such data do not exist at all.

The determination of the technical potential is a completely different task which is based on detailed planning of future power stations in order to assess the output potential. The technical skill of the planner may influence the final estimate. In addition to this personal factor, the final result is influenced very greatly by evolution of design technique. The new techniques developed for the design of very high dams, the new ideas for extensive diversion of water from one catchment area to another and, finally, the new technique for underground stations allow a far better utilisation of the water power over large areas and therefore provide a higher estimate.

The estimate of economic potential depends on further factors :—

(*a*) Technical progress as it affects both specific production costs of conventional hydro-electric and thermal operating plants, and the range of hydro-electric civil construction that is practicable.

(*b*) The rate of increase in demand for electricity.

(*c*) The costs of the various fuels for thermal plants.

(*d*) Changes in interest rates.

(*e*) Prospects for the large-scale utilisation of new sources of power (tidal projects, nuclear energy, etc.).

In addition, in many regions the possibility should be taken into account of more and more accurate surveys and of surveys in areas formerly disregarded. The possibility of transmitting electric energy at ever higher voltages over ever increasing distances may influence profoundly the future economics of water power. Mention should be made here of the existing long-distance transmissions in Sweden and the U.S.S.R and of the future development of the Canadian hydro-power system which will require similar long-distance transmission.

In all European countries the estimates for gross, technical and economic potentials show a steady increase, which testifies not only to the advance of technique but also to the ever increasing pressure of demand from the consumers for more power.

The main results from the careful investigation by the Power Division Economic, Commission for Europe are summarised in table VIII.

The value 'd' depends on the altitude and geographical position of the area. It is equal to 443 for the upper Rhone in Switzerland at 1,340 m average level and is equal to 179 for the Durance Verdon area in France at the level 1,040 m.

It is of great importance to compare the present developed hydro power with the estimated yearly hydro-power production economically exploitable. Table IX gives the figures for the year 1950 for European countries.

The year 1950 was the occasion of the Fourth World Power Conference in London, when many data from countries all over the world were made available. The figures published by the Economic Commission can now be supplemented from other countries. In the United States in 1949, 87,000 million kWh were produced annually by water power generation. In 1952, 109,600 million kWh were produced

TABLE VIII

Estimated National Gross, Technical and Economic Hydro Potential in 1950

Country	Gross yearly potential at full utilisation		Maximum production technically possible	Col. 4 as	Output from projects considered economically possible		Col. 6 as
	10 kWh	kWh/ha	10^6 kWh	percentage of col. 2	10^6 kWh	kWh/ha	percentage of col. 2
1	2	3	4	5	6	7	8
Switzerland	144,000	36,000	70,000	48.6	27,000	6,750	18.7
Austria	152,500	18,200			30,000	3,580	19.7
France	314,000	5,710	138,000	44.0	60,000	1,087	19.2
Germany (E. and W.)	111,000	3,250	26,000	23.4	18,000	510	16.5
Czechoslovakia	39,300	3,080			7,000	548	17.8

The figures in column 5 are of general importance, as they vary inside narrow limits and permit a rough estimate of the power technically possible in an under-developed country where only rough figures of the gross yearly potential are available. At the present stage of hydro-power technique it is not possible to utilise more than half the gross yearly potential, and the economically possible output is usually less than 20 per cent of the estimates for gross power.[3]

On the basis of this survey the Electric-power Section[4] has published a formula for Europe, relating the density of gross potential 'd' in kW/km² to the percentage 'p' of that gross power which is at present technically installable. The formula is

$$p = 0.103d + 9$$

[3] *In a very recent survey by Electricite de France, a figure of* 29% *is reached for France. The French survey is based on detailed studies of actual projects, the technical potential and the economic potential being assumed identical. See M. Rousselier, Directeur adjoint de l' Equipment a E.d.F. 'L'Inventaire des Ressources Hydroelectriques potentielles francaises', Travaux, Vol.* 38, *No.* 240, *October* 1954, *pp.* 737-744.

[4] *E.C.E.* 1953 *Report, pp.* 81-83.

by water power out of a total of about 462,000 million kWh (steam and hydro) and an estimated hydro-power potential of $500{,}000 \times 10^6$ kWh, but these figures are not arrived at on the same basis as those published for Europe. According to reports submitted to the World Power Conference (1950), and others made available more recently, the figures in Table IXa are valid for Canada.

The estimates in this table are based on the actual head or drop at existing falls or rapids or known power sites. No consideration is given to possible economic concentration of head. The increase in the figures for available power between the years 1950 and 1952 is due to extended surveys of rivers. Many great rivers in Canada have never been surveyed in detail. For India, the figures published at the World Power Conference are 25×10^6 kW, equivalent to possibly $220{,}000 \times 10^6$ kWh for ultimate water-power potential. A systematic and comprehensive survey of the water-power potential of India has not yet been undertaken, since, says the report, the cost of such a

TABLE IX

Economic Hydro Potential in Europe in 1950

Country	Area $10^3 km^2$	Estimated yearly hydro production economically exploitable		Already developed, as percentage of total resources	Still to be developed	
		10^6kWh per annum	kWh/ha		10^6kWh per annum	kWh/ha
1	2	3	4	5	6	7
Austria ..	83.8	30,000	3,580	17	25,025	2,990
Belgium ..	30.5	545	170	12	480	150
Bulgaria ..	110.8	6,000	540	6	5,630	510
Czechoslovakia ..	127.8	7,000	550	16	5,900	460
Finland ..	303.9	10,000	330	36	6,360	210
France ..	550.3	59,800	1,090	27	43,610	790
Germany (E. and W.) ..	353.2	18,000	570	50	9,000	250
Greece ..	113.6	4,260	370	—	4,250	370
Hungary ..	93.3	1,500	160	4	1,400	160
Ireland ..	68.9	1,050	150	44	600	90
Italy ..	301.0	50,000	1,660	43	28,400	940
Norway ..	323.8	104,500	3,230	17	86,845	2,680
Poland ..	310.1	5,500	180	9	5,000	160
Portugal ..	88.8	7,970	900	5	7,530	850
Roumania ..	237.5	21.600	910	1	21,400	901
Spain ..	492.4	31,500	640	16	26,500	540
Sweden ..	408.5	50,000	1,220	35	32,520	800
Switzerland ..	40.0	27,000	6,750	38	16,680	4,160
United Kingdom ..	241.7	9,400	390	20	7,525	310
Yugoslavia ..	256.6	50,000	1,950	2	48,900	1,910
Turkey ..	767.1	15,000	190	—	14,970	190

TABLE IXa

Hydro Power in Canada, in Kilowatts

Year	Power at 80% efficiency available 24 hours		Developed capacity (turbine rating)
	At minimum flow (Q95)	Six months flow (Q50)	
Estimate for 1950 ..	20,000,000	37,600,000	8,299,800
Estimate for end of 1952	29,200,000	50,705,000	14,305,880

survey would be out of proportion to its practical value. The potential continuous output of sites already investigated in India amounts to 8.5×10^6 kW, while the installed capacity in 1948 was 576,000 kW with an output of $2,372 \times 10^6$ kWh.

Figures which have been published giving the overall potential of China, Africa and other countries of the world must be treated with great caution. Let us admit that we are here largely ignorant and can do little more than make an intelligent guess.

In a few cases, tidal power may add substantially to the water-power potential. It has been calculated that the Severn tidal scheme near Bristol would yield $2,000 \times 10^6$kWh a year, and the St. Michel tidal scheme in France up to $20,000 \times 10^6$kWh annually.

Recently, a realistic estimate of the world's water power as at the end of 1952 was prepared tentatively by another author and is reproduced here as Table X. The figures in column 3 compare with those in Table VI, and the figures in columns 2 and 6 with those in columns 3 and 5 of Table IX. Columns 4 and 5 show that the power is assumed to be used over a period of 4,500 to 5,000 hours a year (corresponding to a load factor of about .55 which is a fair average) instead of the 8,760 hours used in other computations.

The Future of the Hydro-Power Industry

The future of the hydro-power industry is well worth considering. The task for the next 20 to 50 years will be to fill the gap between the present capacity and output as set out earlier here and the ultimate capacity or output as forecast in previously.

It is possible to collect a certain amount of information bearing on the near future of the hydro-power industry, but far more difficult to obtain precise data for the general planning of the industry over a longer period.

TABLE X

Realistic Estimate of the World's Hydro-electric Power, as at the end of 1952

Countries	Energy in kWh × 10^6 p.a.		Power in MW		% Developed
	Ultimate Developable	Developed to end of 1952	Ultimate Developable	Developed to end of 1952	
North America* ..	807,500	175,000	161,500	32,500	20
Europe (excluding Russia)*	491,100	133,646	98,050	29,625	30
Russia in Europe (say) ..	90,000	20,000	20,000	5,000	25
Siberia and other U.S.S.R. (say) ..	111,000	13,200	25,000	3,000	12
Asia (excluding U.S.S.R. and China) ..	454,000	44,300	88,000	10,280	11.7
China ..	250,000	2,500	50,000	500	1
Australia* ..	24,500	3,000	5,560	605	10.8
Papua and New Guinea ..	66,000	450	15,000	10	0.1
New Zealand* ..	40,000	3,400	8,000	800	10
Africa ..	450,000	1,320	100,000	300	0.3
East Indies, Philippines, Pacific Islands, etc. (say)	66,000	4,500	15,000	1,000	6.7
South America (say) ..	450,000	27,000	100,00	6,000	6
TOTALS ..	3,300,000	428,316	686,110	89,620	13.06

**The figures for these countries are very tolerably reliable estimates of the realisable power.*

Several countries have published lists of the projects now under construction or of those they will be developing in the next two or three years. It is therefore possible to estimate the hydro-power capacity in these countries for the years 1956 and 1957. Table XI gives such a forecast for the end of the year 1956.

all sources will have to be increased by about 6 per cent per annum, with no prospect of the production from coal and lignite increasing more than 3 to 3.5 per cent a year. Water power, possibly along with natural gas and atomic energy, will have to face the bulk of the future increases in demand. Tidal power may have to be considered as part of the future hydro-

TABLE XI

Estimated Installed Capacity and Output at end of 1956

Country	Installed capacity in 1,000 kW		Output in 1,000 millions kWh
	Hydro-electric	Total	
Austria ..	2,132	2,888	9.9
France ..	7,200	13,500	53.4
Italy ..	10,766	13,244	42.5
West Germany ..	2,700	15,000	64.5
United Kingdom ..	700	21,700	73.9
Norway ..	4,320	4,420	23.4
Sweden ..	5,050	6,200	26.4
Switzerland ..	3,700	3,900	15.2

Beyond this very near future, prediction is very difficult. No projects, nor figures, have been published by authoritative sources.

We must base our estimates on the assumption that, for the next ten to fifteen years, the power from

power resources, and a figure of 7 to 9 per cent per annum for these developments is a fair estimate. Roughly, in the next 10 to 15 years the world's developed water power must be doubled or trebled at least, possibly far more. The energy output may rise to three or four times the present figures. This is a colossal

task, as the present standard of production has taken about thirty-five years to attain.

As an example, the following figures for Canada were submitted by Mr. F. L. Lawton of the Canadian Aluminium Company.

Present installed capacity	..	14,700,000 h.p.
Average yearly increase in power demand	..	7.5 per cent
Probable requirement by 1975	..	75,000,000 h.p.

Figures like these require many changes in the present method of approach and in the capacity for production of plant.

There is a feeling among people responsible for the development of water power that long term planning is not given the importance and attention it requires.

For the future, we need to consider the following points.

(*a*) The balance between base load and peak load, between firm power and seasonal power, will probably alter considerably.

(*b*) Very long distance transmission at extra high voltage will have to be adopted. Many of the technical problems involved have still to be solved. Extensive underwater transmission by cable will become normal practice.

(*c*) Migration of people with marked displacements of the centres of gravity of the population may occur. Recently, the increased development of water power in the north-west of the U.S.A. has stimulated considerable migration toward this area. Migration of this type will have to be expected in the future. Financial and demographic planning must go ahead parallel to technical developments.

The planning, designing, tendering and contracting, the manufacture of the plant, and the construction of a large hydro-electric scheme ordinarily take about six years ; in special circumstances it may be slightly less or considerably more. It is not too early to consider now what will have to be done in 1960.

At that date, huge projects now considered somewhat fantastic, like the Yukon River Project or the Hamilton River Project in Canada, the Saint Michel Tidal Project—possibly to be shared by France and Great Britain—and some projects in Africa, may then be close to actuality. In the meantime, important projects like the Snowy Mountains scheme in Australia, the Kafue, Kariba and Volta projects in Africa and many others in the Belgian Congo, India and elsewhere will probably be well under way.

It is highly desirable for the planning of the future to go boldly ahead with designs for new hydro installations, and to engender a greater degree of co-ordination between all the sections of the social organism which are involved.

(*By courtesy of the English Electric Journal.*)

"IRRIGATION & AGRICULTURE IN THE FIRST FIVE YEAR PLAN—AN APPRAISAL"

By

N. S. Joshi & Dr. B. R. Dhekney

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Some Questions Answered

JAISUKHLAL HATHI

There was, as usual, a vigorous debate on the question of execution of River Valley Projects in India, in the Lok Sabha in the month of April, 1955. Sri. G. L. Nanda presented the report of the Ministry and a large number of speakers participated, raising many a question. Sri. Hathi then submitted a detailed memorandum replying to the various criticisms and points made. As some of the issues are of an important character, reflecting both on the policy as well as administration of the Ministry, the Memorandum is given here in full. It will give an inside view of the various problems arising in river valley projects and how they are being tackled in a long term setting.

AUTHOR

Major and Minor Irrigation Schemes

During the budget discussions, the question was raised about the relative place assigned to major and minor irrigation schemes in the Plan. There can be no conflict between major and minor schemes. There are parts of the country in which scope exists for large projects and there are others in which only smaller projects are possible. The largest area should be served by the kind of schemes for which it offers facilities. Large and small projects are thus complementary and not competitive. The First Five Year Plan includes 13 irrigation schemes costing above Rs. 5 crores, 19 schemes costing between Rs. 1 crore and Rs. 5 crores, 20 costing between Rs. 50 lakhs and Rs. 1 crore and about 40 costing between Rs. 10 lakhs and Rs. 50 lakhs.

About 190 irrigation schemes were included in the Plan at a later stage under 'Scarcity Area Programme' and adjustments to the Plan. Out of these about 9 schemes cost between Rs. 1 crore and Rs. 5 crores, 9 between Rs. 50 lakhs and Rs. 1 crore, about 55 between Rs. 10 lakhs and Rs. 50 lakhs and the remaining cost under Rs. 10 lakhs. It would thus be seen that medium and small schemes have a very pronounced place in the First Plan.

The above figures exclude the minor irrigation programme under the Ministry of Food & Agriculture in the current Plan, the whole of which is represented by small schemes generally costing less than Rs. 10 lakhs each. An additional area of about 11 million acres is expected to be irrigated under this minor irrigation programme.

Second Five Year Plan—Regional Balance

The Advisory Committee set up for the selection of irrigation and power projects for inclusion in the Second Plan has scrutinized a number of State schemes. On the irrigation side, apart from the spill-over of the projects originally included in the First Plan, the new projects—Kosi, Rihand, Chambal and Koyna—which were included at a later stage and the Nandikonda Project which has been recently approved, the emphasis in the Second Plan is expected to be more on medium-sized schemes in order that benefits may accrue to the country quickly. In regard to power, the pace of development will be stepped up in order to correlate it with the industrial development programmes during the Second Plan period. While schemes are selected for inclusion in the Second Plan, due regard will be paid to the implementing capacity of the States concerned. Another important factor in the selection of new schemes is regional balance. For instance, Koyna and Nandikonda projects have been sanctioned for the Southern region, Chambal, Kosi and Rihand projects have been approved for the development of the Northern region. Honnemardu, Barapole, Kundah, Tungabhadra (second stage power development) etc., are under consideration for the development of the South; and additional power units at Bhakra, Bokaro and Hirakud and the hydel schemes Jamuna and Ramganga, etc. are being considered for the development of the Northern region.

Rural Electrification

The importance of supplying power at a cheap rate to rural areas for meeting the demands of small-scale industries, lift irrigation and better social life has been fully recognised by Government. The Central Water and Power Commission has been making continuous studies of the various problems affecting rural electrification with a view to finding suitable solutions. The technical, financial, economic and administrative aspects were discussed at a series of meetings in the Planning Commission and in the Engineer's Seminar at Roorkee. A sub-committee of the Seminar specially studied some of the problems in detail and made certain recommendations. These recommendations were then considered at a meeting of the Coordination Board of Ministers held in October 1954 and in accordance with the decision taken by the Board, a circular letter has been sent to State Governments suggesting *inter alia* that the surplus revenues of the electricity undertakings of the State should first be treated as a fund for subsidizing rural

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electrification schemes which work at a loss in the earlier years and that the State Governments should, if any further assistance were needed, submit proposals to the Planning Commission as part of the States' Plans asking for assistance which they may require in connection with the implementation of the schemes.

Simultaneously, in connection with the extension of power supply to rural areas to provide employment opportunities by utilizing existing skill and local resources, the Planning Commission has approved a number of schemes submitted by State Governments for rural as well as small town electrification and have granted loans to the extent of about 20 crores on certain special terms. These schemes are to be implemented during the period of the current Plan. Reports received so far indicate that these schemes have been taken in hand and that by the end of the First Plan, good progress is expected to be achieved in view of the high priority given to these schemes. With the completion of work on these schemes and other schemes executed by States from within their own resources and those financed from development funds the number of villages with electric supply, which stood at about 3075 at the beginning of the Plan period and has now reached a figure of 4,550, will increase to about 6,500 by the end of 1955-56.

To facilitate quick implementation of approved schemes the Central Water and Power Commission has been assisting the State Governments in the procurement of materials to the extent practicable. Further, in order to plan the production and ensure smooth and regular supply of materials, the indigenous manufactuers of these equipment will be given an idea of the needs of the country during the different years of the Plan. The Central Water and Power Commission is also evolving standard and economical methods of construction for adoption throughout the country. The Ministry is fully conscious of the fact that only about ten per cent of the total number of villages in the country are at present electrified and that everything possible should be done to promote the cause of rural electrification. Since at the present rate of progress, it will take a long time to cover the entire country, it is proposed to recommend that a larger amount should be allotted in the Second Plan for the purpose.

Formation of State Electricity Boards

Ever since the Electricity (Supply) Act was put on the Statute Book in 1948, the question of setting up State Electricity Boards has been engaging Government's attention. Till last year, however, such Boards had been constituted only in four States namely, Delhi, Madhya Pradesh, Saurashtra and Bombay. West Bengal has since completed arrangements to set up a Board within this month and the U.P. Government have also agreed to set up one shortly. It has been estimated that between them, these States generate about 60% of the total power in the country.

Other States have been representing to us the difficulties, both administrative and financial, experienced by them in constituting Electricity Boards. To enable such States to overcome these difficulties, we have been extending from year to year the time limit for constituting the Boards. In order to take a final decision in the matter quickly, I convened in February last a conference of State Ministers dealing with electricity. At this conference, some more States agreed to constitute the Boards. It was, therefore, decided to grant a further extension of one year—upto the 31.3.1956 for the purpose. In the meantime, steps are being taken to amend the Electricity (Supply) Act, 1948 so as to remove the difficulties experienced by the States, in setting up the Boards. It is hoped that within the extended time, the remaining States would also set up the Boards either independently or jointly with the neighbouring States.

Absorption of Technical Personnal rendered surplus on projects nearing completion

A complaint was made that no arrangements had been finalized for the further employment of personnel due to be retrenched from the Hirakud and and D.V. Projects as they progressed towards completion and consequently uneasiness was prevailing amongst the personnel concerned about their future prospects.

This question has been engaging the attention of this Ministry ; the Technical Personnel Committee has been examining this question for sime time and their report is expected shortly.

The only rational solution is the proper phasing of the projects so that the surplus personnel from projects nearing completion can be absorbed in new projects. This will help in the utilization of experience gained by this personnel. This Ministry has already given an assurance that there is no dearth of employment for such personnel and that an agency would shortly be set up to arrange placements. Each person would of course have to satisfy two conditions, namely, that his record of service should have been satisfactory and he should be physically fit for further employment.

Experience indicates that regional considerations sometimes come in the way of such placements. I intend to refer this matter to the Co-ordination Board of Ministers at their next meeting.

It may be pointed out these arrangements would relate only to technical personnel and not non-technical administrative personnel or to unskilled labour. The prevailing practice is that such personnel is recruited locally and disbanded when the project is completed. Experience shows that such personnel is reluctant to leave home to secure employment on distant projects.

Estimates

Bhakra Nangal Project

The original estimate for Bhakra Nangal Project

was prepared in 1946. Early in 1949, on account of a major change namely increase in the height of the Bhakra dam by 100 feet. a revised estimate was prepared amounting to Rs. 133 crores. This was a tentative project estimate since a number of points on designs and certain controversial issues regarding inter-State interest on the allocation of water supplies, apportionment of cost of construction etc. had not been settled at that time. A further revision in the estimates was carried out in 1951-52 taking the above factors into consideration as also the rise in the cost of materials and labour, devaluation of the rupee and certain changes in the scope of the works, and the estimated cost at that stage stood at Rs. 156 crores. This estimate was considered by the Bhakra Control Board who issued directions for certain further amendments in the light of facts which came to light during the course of the construction work. The estimate was again revised and amounted to Rs. 151 crores excluding the transmission and distribution system. While the 1953 estimate was under consideration by the Bharka Control Board the Board of Consultants who examined the progress on the project and went into certain technical problems connected there with made some changes in the designs and location of the main Power House. Further revision was, therefore, taken up and in the meantime the question of installation of generating units in addition to the one, originally decided, arose. The final estimate is expected to be ready shortly.

Hirakud Dam Project

The original estimate of the Hirakud Dam Project approved in 1948 amounted to Rs. 48 crores approximately. The total cost of the project was revised at Rs. 89 crores in 1951 and further increased to Rs. 92 crores, incorporating certain changes recommended by the Advisory Committee. The increase was due to increase in the irrigation potential of the projects in the wages of labour and in the cost of land acquisition and compensation for houses etc., and due to the devaluation of the rupee. The Stage 1 of the Project was then estimated to cost Rs. 67 crores. A review of the progress of the project was conducted by the whole-time Chief engineer appointed on the project and in the light of the experience gained on costs of concreting and masonry, requirements of spare parts etc., the estimate for Stage I was further revised to Rs. 70.78 crores. This estimate has been sanctioned.

D.V.C.

In regard to Damodar Valley Corporation, Mr. Voorduin's original estimate amounted to Rs. 37.81 crores. As this estimate was not realistic, the Corporation revised it in 1951. The revised estimate came to about 75 crores. The increase was mainly due to the devaluation of the rupee, rise in prices and extension in the scope of the projects. In the light of experience gained during construction, a further revision was carried out in August 1952 raising the cost to Rs. 88.84 crores. In October 1953, there was a slight increase by 15 lakhs of rupees. According to the latest indications, the total cost is estimated at Rs. 98.97 crores including an amount of Rs. 6.41 crores for a new item involving an extension of the transmission system sanction. A Committee has recently been set up to scrutinize and finalize the latest estimates.

Kosi, Chambal and Rihand Projects

There have been revisions in the estimates for the Kosi, Chambal and Rihand projects also. In Kosi, at the time the execution of the Project was approved in principle, the estimate amounted to Rs. 37.3 crores. As a result of further scrutiny by the Kosi Administration and discussions with the Central Water & Power Commission the figure was raised tentatively to Rs. 42.5 crores mainly because the protective works were worked out in greater detail and the height of the embankment was increased based on the experience gained from similar works in China. Actually, this revised estimate is being reviewed by the whole-time Chief Engieer who has been asked to prepare detailed estimates for the sanction of the competent authority.

In the case of Chambal, the estimate for Stage 1 of the Project prepared in 1952 was 33.75 crores. The estimate as revised in 1954 amounted to Rs. 51.69 crores for this Stage. The main reasons for the increase are increase in the height of the Gandhisagar dam, increased provision for canal system, the original estimate of which was based on incomplete data, and increase in the generating station capacity, transmission lines, etc. It was subsequently decided that one item 'Rana Pratap Sagar Dam' might be excluded from Stage 1. The revised estimate for Stage 1, therefore, now stands at approximately Rs. 48 crores.

In the case of Rihand, the original project estimate was Rs. 35.26 crores. Recently, the U.P. Government invited world tenders for the construction of the dam. Based on the rates quoted by the lowest tenderer the State Government have revised the estimate of this Project to about Rs. 45 crores.

As referred to in my speech on the 5th April initiating to budget discussion, these frequent upward revisions of the estimates of major projects have been causing considerable concern to Government. Excluding modifications in estimates necessitated by increase in the scope of the Projects, the main reason for such revisions has been a general lack of basic data relating to rates of important items of work of the projects. The report of the Committee appointed by Government to look into the matter will, it is hoped, be of real benefit in framing estimates for future projects as accurately as possible, before they are sanctioned.

Rehabilitation and Resettlement

The problem of rehabilitation at Bhakra has been divided into two stages, one is the resettlement of oustees up to R.L. 1250 and the other between RL 1280 and R.L. 1700. The first stage is the emergent

nature because the water will, on the construction of the coffer dam, rise up to RL 1280 by May, 1955. The second stage is equally important though not of an urgent nature. In view of the importance of the problem, the Bhakra Control Board appointed a Rehabilitation Committee including representatives of the affected States. The progress of action was, however, not satisfactory. The immediate issue is the resettlement of 172 families of Bilaspur in Himchal Pradesh. The various points connected with compensation for lands, houses, etc and the resettlement of oustees were discussed at a high level inter-State conference in December 1954. 31 families have elected for resettlement in grass land in Bilaspur itself about R.L. 1700. Punjab has offered to allot lands in the Hissar District in compact blocks as far as possible, for resettlement of the remaining families. A marked preference has, however, been shown by these families for resettlement in a portion of the cattle Farm. The matter is engaging my personal attention and it is hoped that all resettlement operations would be completed before the water rises.

In the case of Damodar Valley Projects, rehabilitation at Tilaiya and Bokaro has been completed. At Tilaiya, the Corporation built 343 houses and reclaimed 4500 acres of land for the displaced persons. Out of these, only 161 houses and 2,745 acres of land were accepted by them. The reason for the non-acceptance of the remaining 182 houses and 1755 acres of land is stated to be that they are not of the same quality as those owned by the displaced persons previously. The matter was discussed at the Conference of the participating Governments held on the 13th July, 1954, and in accordance with the decision taken, a Committee has been appointed by the Corporation to examine and report on the productivity and fertility of the lands already reclaimed and to be reclaimed, welfare measures undertaken by the Corporation for the rehabilitation of the displaced persons and steps necessary for securing the co-operation of the displaced persons in implementing the Corporation's rehabilitation programme. The Committee is expected to submit its report shortly. There is no problem of rehabilitation now so far as Tilaiya is concerned since the persons for whom the 182 houses were intended have built houses elsewhere. The question of disposal of the unoccupied houses and lands is under the consideration of the participating Governments.

At Konar, the Project will displace 5,747 people from 6,672 acres of land and 118 houses, which will be submerged during 1955. The affected people have decided to build their own houses. As for lands, people have opted to take cash compensation for 5,891 acres. Regarding the remaining 781 acres, 401 acres have already been reclaimed and allotted to the affected persons. Against the balance, the Corporation will allot culturable waste lands for which acquisition proceedings are in progress. It is hoped that the final allotment will be completed before submergence.

At Maithon, the construction of the project will displace 24,374 persons and affect 1588 houses and 23,139 acres of land. This covers areas both in Bihar and West Bengal. The problem of rehabilitation arises only in the case of the persons in Bihar, since the entire area of submergence lies in Bihar (9794 acres in Dhanbad and 13,345 acres in Jamtara). In order to enable the Corporation to proceed further with the construction of houses and reclamation of lands for the displaced persons, it is necessary to obtain options from them for lands and for houses.

The following resolution was passed on this subject in the Conference of the Participating Governments held on the 13th July, 1954:

"The persons to be displaced should be asked to give their options within a stipulated period failing which only cash compensation should be paid. A legally-binding form of exercising option should be drawn up. The land to be offered as compensation should, as practicable, be of the same productivity as the land acquired. Care should be taken at the same time to see that the costs do not mount up unnecessarily."

In pursuance of this recommendation, notices in Hindi, Bengalee and Santhali were issued to the people by the District officers concerned and a drive was organised with the assistance of the Corporation for collecting options. A number of centres was opened conveniently throughout the reservoir area and the officers of the Rehabilitation Department moved about the affected villages and approached the people for giving options. The 30th September, 1954, was fixed as the last date for giving their options. The response was poor and at the instance of the Deputy Commissioner Santhal Parganas and the Additional Deputy Commissioner of Dhanbad, the date was extended to the 31st October, 1954. A renewed approach was then made to the people. After this date, the option papers were collected and the results tabulated. After a quick field examination of the villages in which some of the displaced people had sought land, the Corporation examined the matter with the utmost despatch and sent its concrete proproposals to the Government of Bihar on the 21st Decenber, 1954.

The Corporation noticed that delay was taking place in finalising the award and, to mitigate hardships to the affected persons, sanctioned, with the consent of the Bihar Government, an advance payment of 50% of the estimated house compensation. The Corporation has also requested the Bihar Government that those who have not opted for land should be paid compensation cash as quickly as possible and the Collectors may be asked the expedite such payments.

It has been found generally that the people are unwilling to take the land reclaimed by the Corporation. They are selecting their own sites which in some

cases are unfit for reclamation. The Bihar Government are conducting a survey of the land selected by some of the people to enable them to decide which classes of land should be acquired for rehabilitation. Certain controversial issues raised in this connection have been taken up with the Bihar Government.

The construction of the Panchet Hill project will displace 29,884 people from 22,670 acres of land and 2,630 houses. The Corporation have tentatively decided to acquire lands and houses upto EL 425 and only houses in the belt between EL. 425 and EL-435. The area of paddy land which will be submerged will be 7448 acres. It has been estimated that the total area for which replacement of paddy land may be wanted, would at most be 4,200 acres. An area of about 8000 acres suitable for paddy land and about 9000 acres suitable for tanr land have been located. Therefore, no difficulty is apprehended about land for reclamation.

As in the case of Maithon, it has become extremely difficult to obtain options from the affected people. Only recently 72 families in 5 villages (total families affected being 4602) have opted for cultural waste land. As the dam is scheduled to impound water in the monsoon of 1956, a drive for obtaining final options will be organised shortly, with some date in June, 1955, as the last date for recording the options.

Hirakud

The Government of Orissa are responsible for all matters connected with land acquisition, payment of compensation, reclamation of land and resettlement of displaced persons in the reservoir area.

244 villages will go under water no completion of the Hirakud Dam, 111 of which will be submerged fully and the rest partly. In regard to the former, 95 villages have been offered compensation to the tune of Rs. 3½ crores and 92 villages have accepted the compensation. In regard to the latter, the submersion ranges between 5 to 40% in a large number of cases and basti sites will go under water in 50 villages only. In villages where compensation has not yet been paid, preliminary works such as field enquiry, preparation of estimates, etc, are in progress. The State Government have confirmed that in land acquisition, they are ahead of submersion.

50 villages will be submerged during the ensuing monsoon. Compensation has been paid to 49 villages. It will be paid for the remaining villages before June 1955.

The Government of Orissa have intimated that the reclamation camps established by them for resettling the displaced persons are mostly outside the ayacut area of the Hirakud project. Only 80 acres of land inside the ayacut could be taken up for reclamation. A survey of irrigable waste lands on the canal sides in various villages was made and this has revealed that these waste lands do not require any reclamation. These lands are proposed to be allotted for resettlement as far as possible.

Up-to-date, the State Government have taken deposits of a total amount of Rs. 10.13 lakhs for 17 camps. According to the rates at which land is available in these camps, this amount represents the value of an area of about 4759 acres. As against this demand, there are on hand 6532 acres of cultivable fields in these 17 camps. There is an additional area of 3000 acres which has been cleared of forests and destumped and kept ready for field making. At present every month, an area of 150 to 250 acres is beng made into fields. The State Government's policy is to confine the rate of progress of reclamation to the demands by the persons affected plus a margin of about 2000 acres ordinarily sufficient for resettling 200 families.

The 50 villages which will go under water in the 1955 monsoon have a population of about 29,000 people and contain 6172 khuntis. The owners of 3319 khuntis have made arrangements for resettlement at places other than the State Government's reclamation camps. The owners of 832 khuntis have deposited money for resettlement in these camps. It is clear that by far the larger number of people are not settling in the reclamation camps, the main reason being the availability of land in well-settled villages for purchase. Recent legislation bestowing occupancy rights on the tenants in Sambalpur District has made lands saleable and big land-holders, being afraid of legislation fixing the maximum limit of ownership, are disposing of lands. The remaining families are actively engaged in making arrangements for their resettlement.

In the resettlement camps of Government facilities are being provided in excess of those commanded by the villagers in the area to be submerged. House sites are given free for construction of houses for the resettlers. Timber is provided at concessional rates. Brick is made centrally and sold at cost price. Roads are provided ; hospitals are under construction, as also schools and bhagbatghat. A medical officer has been posted to look after the health of the resettlers. For the convenient shifting of the people, it is proposed to construct a few transit camps with 500 tenements. The State Government are also constructing 500 extra tenements in the reclamation camps. All these 1000 tenements will serve as accommodation for such people as fail to make arrangements for themselves in time.

Tungabhadra

The plan to raise the level of the reservoir from RL 1630′ to RL 1635′ is not a recent decision. The scheme, as originally sanctioned by the Governments of Madras and Hyderabad contemplated the level of the reservoir to be at RL 1633′ plus a margin of 2 ft. for the back water and wave action. This is borne out by the fact that, according to the original estimate, 33 spillway gates of total height of 20′ were to be placed over the spillway section at RL 1613. The top of the spillway

gates should, therefore, necessarily be at RL 1633′, and in that case the level of the reservoir would normally be the same. If the level of the reservoir were lower, it will be a case of not exploiting to the fullest extent the capacity of the reservoir. Further, it has been reported that the notification to acquire lands upto a contour of 1635′, was issued as early as 1941-42. Had there been no idea of raising the level of the reservoir upto that height, there would have been no need to issue such a notification. In September 1953, the Chief Engineers of Mysore and Hyderabad met in a conference and decided to acquire land upto 1633′ for the reservoir and 2′ above it for plantation and conservation. The Tungabhadra Board duly considered this matter and decided to acquire the land upto contour RL 1635′ straightaway.

From the reports received from the Tungabhadra Board, it appears that one village, earmarked for rehabilitating people displaced earlier as a result of the acquisition of land upto 1630′ is being affected by the raising of the level from 1630′ to 1635′. This village comprises about 28 acres of land of which 3 acres will be submerged. However, this area is still lying *vacant*, the allottees not having built houses there. These persons will be allotted land elsewhere. On the Hyderabad side no rebuilt village is affected. In the circumstances it is not correct to say that many displaced persons have built houses and purchased lands in this area at pretty high rates, sometimes paying Rs. 10,000 per acre, and will again be moved due to the submergence of their newly acquired lands and newly built houses.

As a result of the raising of the level of the reservoir by 5 ft., 4850 acres of land and 6,200 houses in Hyderabad, 5,580 acres of land and 2,035 houses in Mysore are to be acquired. The rate of compensation relating to Hyderabad is not readily available. As regards the Mysore side, when the Notification was issued in 1941-42 by the composite Government of Madras, the rate of compensation was fixed according to the formula :—

Compensation 100% (of 1941 rates)
Solatium—15%
Ex-gratia for general rise in prices—85%
Total :—200%

Compensation is proposed to be paid for the properties to be acquired now, on the same basis.

Stores, Plant and Machinery

At Bhakra, stores worth Rs. 4 crores are in stock and ample spares for the machinery in use have been arranged. Most of the construction plant required for the dam has arrived and is under erection. The 'health' of the earth-moving machinery in operation on this project has been gone into in detail. The figures show that efficiency continues to improve and that breakdowns are decreasing. For instance the efficiency i.e. effective working hours as compared with the basic schedule, has in the case of Electric Shovels increased from 77.2 in May 1954 to 119.3 in January 1955 ; in the case of Diesel shovels (over 2 cu. yds) from 52.0 to 75.8 ; in the case of Euclid trucks from 40.9 to 88.5. The average duration of breakdown including overhaul has, for Electric shovels, decreased from 25.2 hours to 9.5 hours ; for Diesel shovels (over 2 cu. yds) from 34.7 to 26.7 hours ; and for Diesel shovels (under 2 cu. yds) from 32.1 to 11.6 hours.

At Hirakud, there is now a separate field organisation for daily maintenance and weekly servicing of equipment and machinery. This organisation attends also to heavy repairs in the field of all hauling units and basic machinery. This arrangement has made it possible to maintain better health and efficiency standard for all machinery. Another improvement is the introduction of kerb side pumps to refuel the machinery with high speed diesel oil, at a number of places in the field camps. This has made it possible to avoid annual handling and has resulted in fewer breakdowns. The position of stores and spare parts is satisfactory. Pricing of all stock items has been done. A complete list of surplus stores has been prepared ; there are 20,000 items valued at approximately Rs. 1 crore. The book value of these stores is being worked out.

The position in the Damodar Valley Corporation, on the other hand, in regard to spares and 'health' of the machinery does not appear to be satisfactory. At Maithon and Panchet Hill, difficulties are being encountered in the operation of the machinery to full capacity. Delay in the receipt of spare parts in order is leading to frequent breakdowns. The matter is being attended to on a priority basis, to avoid any postponement of the target dates of completion.

Labour

Hirakud

The existing strength of labour at Hirakud is about 10,500 departmental and 24,800 under contractors, both skilled and unskilled. Hutting accommodation has been provided as far as possible. 3391 'F', 'G' and 'H' type quarters have been built for departmental workers. Provision has been made for filtered water supply, sanitation, medical aid, street lighting etc. There is an open air theatre where festival celebrations and social gatherings are held ; film shows of documentaries are also arranged. Community radio sets have been provided. Congregational halls and welfare centres have been opened. Sun glasses are provided for protection against glare. Free transport is arranged to carry workers engaged on earth-moving equipment to and from the work sites. There are fair price shops in the colonies. Free medical aid is given. Ample capacity exists in the two hospitals at Burla and Hirakud colony. Mobile dispensaries and first aid posts have also been established. Ambulance service exists on both sides of the river. The Workmen's Compensation Act is applicable to all workers on the Project. The Factory Act is applicable to workers in the workshops only. A Safety Engineer has been posted to give advice on safety devices. Posters and placards have been exhibited at all danger zones.

Lower Primary Schools have been started in the two Labour Colonies. A Labour Welfare Officer has been appointed to look after the needs of the departmental and contractors' labour.

Bhakra-Nangal

The work on the construction of the Bhakra Dam is being done departmentally and all the labour engaged there is on work charged basis. The present strength of skilled and unskilled labour working on the Project is 7,825. A number of facilities have been provided to them by the Project authorities. Rent free accommodation has been given to the workers as far as possible. Those who are not provided with accommodation are granted house rent allowance in lieu thereof. Community bath rooms, sanitary latrines and street lighting have been provided in the workers' colony. Electric lights in individual houses have been given where workers deposit security and agree to pay for power. Sufficient water taps have been provided in streets which run for about 16 hours a day. A fully equipped hospital with all modern medical facilities such as X-ray, is maintained on the Project. Welfare centre has been opened in the workmen colony at Nangal with a lady Health Visitor who pays house to house visits. A recreation centre has been opened at Nangal where free indoor and outdoor games and newspapers and library books are provided. A safety organisation has been set up to arouse the safety consciousness amongst the workers in order to prevent accidents. Free transport arrangements exist for carrying the workers to work sites.

A High School for boys and girls has been opened at Nangal in addition to the Primary School. Free concessions are given for sons and wards of low paid workers at these schools. A Labour Welfare Officer has been appointed for looking after the problems relating to the general welfare of labour.

Damodar Valley Corporation

During the year the labour situation has on the whole remained peaceful in the Damodar Valley Corporation except for a temporary cessation of work by the labourers at Durgapur from the 9th March, 1954 and a notice of strike received from an unrecognised workers' union at Maithon on March, 1955. The Durgapur incident related to the labourers' demand for increased wages and other amenities. The strike gradually fizzled out and the majority of the workers returned to duty on the 19th March, 1954. An amicable settlement was arrived at on the 23rd April, 1954, and the strike was officially abandoned.

At Maithon, the Damodar Valley Corporation had decided to close the Timber Workshop from 1.4.1955, on the ground that it was no longer necessary. In pursuance of this decision, notice was served on workers of this Workshop, terminating their services from 31.3.1955. An unrecognised Workers' Union at Maithon resented this decision and submitted a list of demands urging *inter alia* that the Timber Workshop should not be closed, and gave notice of a strike to commence on the 26th March, 1955, in case the demands were not accepted. Assisted by the Labour Commissioner, Bihar, the Damodar Valley Corporation, started negotiations with the representatives of the Union. As soon as the matter was brought to my notice, I issued an appeal to the Workers to desist from the strike on the assurance that their reasonable demands would receive consideration. I also contacted the Labour Organisation likely to have influence with the Workers at Maithon and as a result of goodwill on all sides, an amicable arrangement was arrived at between the Workers and the Corporation resulting in the withdrawal of the strike notice on the morning of 27th March.

The labour strength during the year has varied from 10,000 during the slack season, to its present figure of 50,586 (28.2.1955). The details of the present strength are as follows :—

	Unskilled	*Skilled*	*Total*
(*a*) D.V.C. workcharged establishment ..	1,858	6,013	7,871
(*b*) D.V.C. Muster Roll	7,351	3,308	10,659
(*c*) Contractors' employ	30,488	1,568	32,056
GRAND TOTAL	39,697	10,889	50,586

For the welfare of the labourers, additional houses were constructed at different work-sites. It has not, however, been possible to provide family accommodation for the extra strength of labour. Arrangements for their recreation and medical attention were enlarged. Sanitary measures and prophylactics against epidemics were intensified.

Foreign Specialists

No foreigner is employed at Hirakud. There was one specialist under the Colombo Plan attached to this project last year, to give advice on the operation and maintenance of machinery. He recently left on the expiry of his contract. We have asked for his services again for some time longer.

In the Damodar Valley Corporation, there is at present only one foreign expert employed on contract basis i.e. the Chief Engineer. As already stated an Indian under-study has been appointed to the Chief Engineer. There are in addition 4 experts under the Technical Aid Programme, who are functioning in an advisory capacity. The number last year was 4 and 11 respectively.

Foreign experts in comparatively large numbers are employed at Bhakra. This has been necessitated by the specialised types of machinery in use on that project and the highly intricate technical work involved in the construction of the dam. In all 96 Americans were originally appointed and the number is being gradually reduced. It now stands at 43 as against 63 in March 1954. Indian officers are receiving training under them and will replace them as soon as

they gain the requisite experience. These eperts were selected after a full enquiry of their qualifications and experience. Even though the majority of them do not possess academic qualifications, they have long practical experience in their own speciality. No Indian expert has been kept out from a position of responsibility because of the employment of foreign technicians. All important adminstrative and technical posts are held by Indians and work of the specialists is restricted to the field in which their advice is required. The Bhakra Control Board and the Government of Punjab are vigilant in the matter and constantly review the position with a view to reducing the number of such specialists. It should, however, be made clear that we do not mind the engagement of foreign experts as such so long as they are necessary in the interest of the efficient and expeditious execution of works on the projects.

Nandikonda Project

The proposal of the Government of Madras for the inclusion of two projects, namely Krishna-Pennar and Rampadsagar, preferably the former, in the second part of the First Five-Year Plan, was examined by the Planning Commission who considered that it would not be possible to include in the Plan two such big projects. An expert Committee under the Chairmanship of Shri A. N. Khosla was appointed to examine and report to Government on the optimum utilisation of the waters of the Krishna and the Godavari Rivers. With a view to getting quick results in food production and to providing for the ultimate needs of all the areas which can be physically served by the Krishna river within limits of economic feasibility, the Khosla Committee recommended the following proposals :

Stage I. (*i*) The remodelling of the existing Kurnool-Cuddapah Canal to serve the famine stricken areas of Rayalaseema ;

(*ii*) The construction of a high dam on the Krishna at Nandikonda.

Stage II. (*i*) The construction of a dam (13.5 ft. lower than that contemplated in the Krishna-Pennar Project of 1951) at Siddeswaram ;

(*ii*) A feeder channel leading to the Pennar, the Krishna Pennar West Canal and some of the branches of the Nandikonda Right Canal left out in the First Stage.

Stage III. (*i*) The construction of a dam at Pulichintala to provide for additional irrigation for second crop in the Krishna Delta.

After examination of the recommendations of the Khosla Committee, the Planning Commission asked the State Governments of undivided Madras and Hyderabad to prepare a joint report on the Nandikonda Project. The joint report submitted by Andhra (successor State in respect of the Project) and Hyderabad estimated the cost of the Project at Rs. 122 crores. The joint report was scrutinised by an *ad hoc* Technical Committee in regard to the scope of the project, the estimated costs, etc. The recommendations of this Committee were forwarded to the Government of Andhra and Hyderabad for comments.

An inter-State Conference was held in the Planning Commission on the 24th February, 1955, in which the project was discussed in the light of the recommendations of the Technical Committee and the comments thereon of the Andhra and Hyderabad States. A decision was taken to include the Nandikonda Project in the First Five Year Plan. It was at the same time made clear to the representatives of the State Governments that the acceptance of the Stage I of the Nandikonda Project involved no commitment in regard to other projects on the Krishna.

The project comprises the construction of a masonry dam across the Krishna at Nandikonda and two canals taking off from the reservoir on the left and right banks in Hyderabad and Andhra State respectively. The average height of the spillway dam above foundation level will be 302 feet. The First phase of the Project is estimated to cost Rs. 75 crores. The scheme will irrigate about 2 million acres of land in the districts of Guntur, Kurnool and Nellore in Andhra and Warangal and Nalgonda in Hyderabad State.

The State Governments are separately taking action to implement the decisions taken at the Conference before preliminary work on the project is started. Steps are also being taken in consultation with the participating States to set up a Control Board to be in over-all charge of the Project.

The joint report on the Nandikonda Project has provided for irrigation of Kaveli-Kanpur canals from the Right Bank Canals. The Technical Committee has suggested that these canals be fed through Kurnool-Cuddapah Canal by remodelling the latter and increasing the capacity from 3000 cusecs to 6000 cusecs. The Andhra Government have agreed to investigate this proposal. If this is technically feasible, the alignment of the Right Bank Canal which is taken along a high contour, will have to be shifted to a lower contour, which is likely to effect considerable saving.

Somasila Project

The Andhra State has not supplied the detailed Project Report on the Somasila Dam. All projects have to be examined in detail by the Technical Advisory Committee before being recommended for inclusion in the Second Five Year Plan. The scheme will be considered when it is submitted by the State Government.

Tungabhadra High Level Canal

The Tungabhadra High Level Canal Project as proposed by Andhra consists of the following :—

(*a*) Main Canal, Guntakal Branch and Uravakond cut ;

(*b*) Mid-Pennar regulator on the Pennar river with a canal on each bank ; and

(*c*) Gaddi-kota weir on the Pennar with a canal on each bank.

The High Level Canal will take off from the Tungabhadra Dam and is envisaged to irrigate 80,000 acres in Bellary district of Mysore and 3,00,000 acres distributed in detached areas in Anantapur, Cuddapah and Kurnool districts of the Andhra State. The Project is estimated to cost about Rs. 19 crores.

The inclusion of this Project in the Second Plan is under consideration. The Project is being technically scrutinised by the Central Water and Power Commission. Some points of difference between the Government of Mysore and Andhra have been brought to Central Government's notice. It is proposed to convene an inter-State conference to resolve these differences.

Rapti and Ghagra Basins

Shri M. L. Agrawal referred to the development of the Rapti and Ghagra Basins. Detailed investigations in these basins are in full swing. Some detailed estimates and plans have been drawn up for schemes on the Ghagra and Rapti. A few have been taken up for construction and others are under scrutiny. After the completion of surveys now in hand, comprehensive schemes will be drawn up to control floods effectively in the Ghagra and Rapti. Many of these schemes are expected to be beneficial for irrigation purposes as well.

Assam

The position in regard to the points raised by Shri Deb is explained below :

Storage Dams

Reconnaisance surveys for possible dam sites are in progress and the sites are being inspected by Engineers and Geologists. Only after the preliminary reports have been prepared and examined, can a decision be taken regarding the construction of storage dams at any of these sites. The sites under investigation were decided in consultation with the State Government (Government of Assam). Investigations on other sites will be taken up later.

Dredging the Brahmaputra and the Barak Scheme

Dredging as a flood control measure in the Brahmaputra has been investigated in detail. Our engineers do not hold out any possibility of adopting this measure in the Brahmaputra. It may be useful in smaller rivers and under different conditions as in the Kosi.

Investigations are in progress on the Barak river. Hydrological observations are being made. It is hoped that by next year, a programme of flood control for this basin, may be available.

Palar Dispute

Dr. Ramchander and Shri Singham referred to the 'dispute' between the Government of Madras and Mysore regarding the utilisation of the Palar waters. The Government of Mysore maintain that they are not making additional abstractions from the Palar river. The Government of Madras however desire that the matter should be examined by the Government of India.

A further communication has recently been received from the Government of Mysore. They have pointed out that the Government of Madras have not so far addressed them on the subject and that it should be possible to deal with any points which require clarification by correspondence between the two State Governments or by mutual contact. After a careful examination of the communication, the Government of India have suggested to the Madras Government that it will be desirable to have the question settled amicably by discussion between the representatives of the two State Governments and that if both the sides felt it necessary to have a representative of the Centre present during the discussion, the Government of India will depute an Officer for the purpose.

Kundah Project versus Barapole Project

Different suggestions were made in regard to the priority of the Kundah and Barapole schemes for execution. These two schemes are directly connected with regional development, since both serve practically the same area. In the wider interest of the region, it was necessary to examine in detail the economics of the two schemes.

The report of the *ad hoc* Technical Committee which examined the scheme was sent to the Government of Coorg and Madras for comments. The reply of the Coorg Government was received in the last week of March 1955. The Madras Government's reply was received recently. The replies are under consideration.

Lakhshman Tiratha Project and Harangi Project in Coorg

The execution of the Harangi Project and the completion of investigations on the Lakhshman Tirath Project were urged by Shri Saxena. These two projects were investigated by the Central Water and Power Commission in the first instance. The project proposals are under examination in the Commission.

Power Development in Uttar Pradesh

Shri Agrawal showed by figures that the per capita consumption of electricity in the country was very low compared with Norway. He further stated that the per capita consumption in Uttar Pradesh was very low compared with Mysore, Bombay, Madras etc. He indicated that Uttar Pradesh did not get fair deal in allocation of funds for development ot electricity in the first five year plan.

Before the plan Uttar Pradesh had an installed capacity of 183840 kW. At the end of the first five year plan, the installed capacity will be 313300 kW ; when all the schemes of the first five year plan are completed, the installed capacity is expected to be 496300 kW. (i.e. 1 : 1.71 : 2.70). This may be compared with all India figure of 2.712 MKW., 2.908 MKW and 4.034 MKW respectively (i.e. 1 : 1.70 :

2.35). Thus it will be seen that Uttar Pradesh has not been neglected in any way.

Development of Hydro-Electric Power in the Hills of the North-Eastern Region

Shrimati Khongmen suggested that Hydroelectric schemes might be undertaken in the hills of the north-eastern regions particularly for raising the standard of living of tribal people.

The hydro-electric project at Umtru in Assam (installed capacity 7000 kW) is under execution. Investigations on further development of power in this Project are in hand.

Investigations have also been taken up for hydro-power schemes in Manipur and Tripura.

A scheme has been formulated for conducting experiments for the development of hydro-electric power by utilising the natural flow of small streams in hills within short distances of small villages, and making power available to these centres at the minimum cost practicable. The experiments are proposed to be conducted at selected sites in 1955-56 at an estimated cost of about Rs. 2 lakhs.

Development of Power in India as compared with China

We have no authentic information whatever about the production of electrical energy in China (mainland). Even the statistics issued by the ECAFE, the regional organisation for Asia and the Far East countries do not contain any information pertaining to China (mainland). It is, therefore, not possible for us to make any comparison between the figures of electricity production in China and in India. However, we would point out that there is no basis for the assumption that power produced in the country could not be sold or that the power generated was not utilised. There has been some delay in utilisation, for instance, in the Damodar Valley Corporation, the reasons have been explained already.

(i) D.V.C. Power to Calcutta Electricity Supply Corporation

Shri Basu complained that Calcutta Electricity Supply Corporation was being supplied with power from D.V.C. at a cheap rate but would not reduce their rates to consumers, thereby earning large profits. There is no basis for such an apprehension. According to the Electric Supply Act, 1948, no undertaking will be allowed to make a profit in excess of 5% on the capital base. If supply of power by D.V.C. at the rates contracted for results in a profit in excess of 5% on capital base, the Company is obliged in terms of the Act not to distribute to the shareholders profits in excess of 5% but to reduce the rates suitably. The Act provides for the Bengal Government to set up a Rates Committee if the State Government feel that the rates charged by the Corporation are likely to bring in profits in excess of 5% on the capital base.

Shri Basu said that power from Ganguwal Power House could not be fully utilised and that there was no plan for the immediate supply of power from Bhakra and D.V.C. projects to new industries that were growing up. This is not a correct picture of the position. With the supply to Delhi, 19,000 kW out of the firm capacity of 24,000 kW of Ganguwal Power House have been utilised and the balance will, as I had pointed out, be absorbed by the end of May, 1955. Power from both the projects will, of course, be available to new industries in the regions concerned. For this purpose detailed load surveys have already been made by the Project authorities.

(ii) Alignment of Canals—D.V.C.

The procedure followed by the D.V.C. in fixing alignment of the canals is as follows :

(*a*) On the basis of contour maps and plans available for the area, a tentative alignment is suggested in the Design Office, which is usually shown in the Preliminary Layout Plans ;

(*b*) These alignments are then reproduced on large scale mouza maps and the maps sent to field officers for any alternative alignment in order to ensure maximum command and minimum expense on the system ;

(*c*) These suggestions and detailed surveys are then studied in the Design Office and the alignment which is most suitable on technical as well as economic considerations is approved ;

(*d*) After the designs of canals is finalised, the land acquisition plans are prepared and sent to the Special Land Acquisition Collector for further action.

Consistent with the above procedure earnest attempts are made to avoid houses and valuable land but that is not always possible and some hardship, in fact, results.

Some allegations in this connection were received in 1954 to the effect that the alignment in some places were changed to save the property of certain influential persons, without any technical considerations. The D.V.C. have confirmed that these allegations are not correct. The Corporation explained in this connection that certain original alignments were, on a detailed on-the-spot survey, found to involve detour and prohibitive cuttings including the provision of a large number of extra cross-drainage works. These alignments were, therefore, rejected by the Corporation on technical and economic considerations. In certain other cases, the original alignments had to be revised to meet the objections of the Government of West Bengal, that the alignments proposed interfered with the State Government's existing irrigation schemes.

Bhakra Nangal Project

(*i*) *Punjab Public Accounts Committee's Report*

A reference was made to the observations of the Public Accounts Committee of the Punjab Vidhan Sabha and it was desired that the Government of India should get enquiries made into these observations.

The Report of the Punjab Public Accounts Committee is under the consideration of the Bhakra Control Board and the Irrigation Department of the Punjab State. This Department is making all efforts to remove the defects and to rectify the accounts irregularities, which were according to the project authority unavoidable in the unprecedented rush of construction.

A sub-committee of the Bhakra Control Board has already examined the report and submitted an interim report, to the Board.

(*ii*) *Utilisation of Power*

Two units of 24,000 kW. each have been installed in Power House No. 1 at Ganguwal. This Power House was brought into commission in January, 1955. The firm capacity of this Power House is 24,000 kW. since one of the sets will be kept as a standby. Power to the extent of 8,500 kW is being utilised at present. 10,000 kW will be supplied to Delhi by about the middle of this month. It is expected that the firm capacity of 24,000 kW. will be entirely utilised by the end of May, 1955. From that time to the date of commission of the Second Power House at Kotla, it will be necessary to use the stand-by set for about a few hours every day to meet the peak load.

(*iii*) *Postponement of Diversion*

Diversion of the river scheduled for winter 1953-54 was postponed to October, 1954, on account of considerable delay in the receipt of machinery and spare parts. A few instances are given below :—

(1) Order for one $5\frac{1}{2}$ cubic yards electric shovel was placed on Indian Stores Department London in May, 1952. Immediate delivery was offered. The shovel actually arrived in January, 1953, but the cable and the transformer which were to be used with it wer received only in July and March, 1953 respectively.

(2) Order for two $2\frac{1}{2}$ cubic yards electric shovel was placed in November, 1952, but the shovel was actually received at Nangal in September, 1953. The scheduled date of delivery was March, 1953. Even when the shovel arrived, it came without the cable which arrived long afterwards.

(3) 16 orders were placed from time to time for spare parts for Marion shovel. The first order was placed as early as January, 1953, but the consignments did not start arriving at Calcutta till September, 1953 and continued over a long period.

Other instances could also be quoted. The steel strike in U.S.A. was responsible to a large extent in delayed arrival of machinery and spare parts. Constant reminders were issued, and the matter was also pressed at high level by our representatives in Washington and London.

Purchase of Machinery in Bhakra Dam Administration

Following procedure is followed :

Concurrence of competent financial authority and the Bhakra Control Board is first invited. In most emergent cases where the cost of machinery exceeds Rs. one lakh, approval of Bhakra Control Board is anticipated, but the decision is got confirmed from the Board in its next meeting. In the case of spare parts covered by the price agreements of D.G.S.& D. with various suppliers, orders for Ex-Stock agreements are placed directly on these firms on the basis of the price agreements. In the case of forward delivery requirements of items not covered by the price agreements, competitive tenders from the manufacturers and other firms in America and India are called and orders are placed on the lowest quotation received. In other cases all India tenders and also some time global tenders are invited. Over 4500 orders have been placed since 1952 and only in 14 cases open tenders were not invited. These were very urgent cases and very favourable deliveries were offered. The quotations received were also satisfactory. No machinery is purchased by Mr. Slocum, or the Technical Attache in Washington, whose name was mentioned by S. Hukam Singh on 5.4.1955. The procedure is that the Technical Attache calls for tenders on receipt of enquiries from India, sends all the tenders received by him to India for scrutiny in the General Manager's offce. The General Manager, after scrutiny, issues orders to the Technical Attache for placing all orders. The Technical Attache or Mr. Slocum is not entitled to place any order without specific authority from the General Manager.

Out of about Rs. 6 crores worth of machinery, second-hand machinery purchased (*vide* list attached —Appendix A) is worth only Rs. 27,57,000/-. This includes machinery worth Rs. 1,25,000/- purchased from the Disposals. All the second-hand machinery is in good condition and is in use or is under erection. The question of purchase of second-hand machinery was considered by the Union Public Accounts Committee at its meeting held on the 9th September, 1952, and the representatives of the Bhakra Nangal Project and the Ministry of Finance gave evidence in this behalf. It has been confirmed by the Ministry of Finance that at the instance of the Committee, the the Comptroller and Auditor General looked into the matter further. At the meeting of the Committee held in October, 1954, the representative of the Ministry of Finance informed the Committee that the Comptroller and Auditor General had examined the entire transaction and found it to be in order.

The new machinery is also either in use or is under erection. The construction plant is expected tc have its first trial in May-June next.

(*v*) *Details of Net Additional Expenditure by shifting the site of Bhakra Dam Power House*

If the installation of only one penstock and the sub and superstructure for 4 units and service bay is considered, the extra cost of shifting the powerhouse is 24.67 lakhs. Should the installation of all the six penstocks and the sub and superstructure for 6 units and service bay be considered, the extra cost will be 37.69 lakhs. Details are given below :

ALTERNATIVE I

Analysis of cost considering installation of Penstock I only (as provided in Project Estimate of 1954) and Sub and Superstructure for 4 units and service bay.

	Excess Rs. lakhs	*Saving* Rs. lakhs
1. Excess in foundation treatment due to 85 feet shift excluding units 5 & 6 as compared with old location.	24.59	
2. Saving on account of excavation as between the old location and the new location for 4 units and service bay and other small items		1.86
3. Excess due to increased length of penstock No. 1 and connected items.	3.94	
4. Saving due to other works that would have been necessary for the stability of the power plant itself at old location.		2.0
	28.53	3.86

Net excess Rs. 24.67 lakhs.

ALTERNATIVE II

Analysis of ultimate cost of installation of 6 penstocks and sub and superstructure for 6 units and service bay.

	Excess Rs. lakhs	*Saving* Rs. lakhs
1. Excess in foundation treatment due to 85 feet shift including units 5 & 6 as compared with old location.	39.95	
2. Saving on account of excavation as between the old location and the new location making allowances of higher rates of excavation which had to be paid for excavation of units 5 and 6.		26.41
3. Excess due to increased length of penstocks No. 1 to 6 and connected items.	26.15	
4. Saving due to other works that would have been necessary for the stability of the Powerplant itself at old location		2.0
	66.10	28.41

Not excess Rs. 37.69 lakhs

(*vi*) *Bhakra Control Board*

It is not correct to say that the same officers are continuing on the Board even after retirement. The following changes may be noted :

	Original	*Now*
Chairman	Shri C. L. Trivedi, Goveror in his personal capacity.	Shri C. P. N. Singh Governor in his personal capacity.
Vice-Chairman	Shri A. N. Khosla, Chairman, CW&PC	Shri T. Sivasankar, Secretary, Ministry of Irrigation & Power
Punjab	Shri Sarup Singh, Chief Engineer.	Shri S. D. Khungar, General Manager.

As a matter of fact, the officers of Punjab, Pepsu and Rajasthan who are Members of the Board have been notified in the Resolution by *designation* and not by name.

(*vii*) *Joint Secretary in the Ministry*

My statement that Shri R. R. Bahl (then Joint Secretary in the Ministry) did not set foot in the Bhakra Nangal Project is not quite correct. On verification, I have found that he visited the project once when he went to attend the opening ceremony of the Ganguwal Power House in January, 1955.

(*viii*) *Gurgaon Project & Bhiwani Tehsil*

A project report for Gurgaon Canal has been sent by the Government of Punjab for inclusion in the next Plan. The Project consists of a canal of 1,000 cusecs discharge to take off from Okhla weir by the side of the Agra Canal. It will serve an area of 3.5 lac acres of Palwal, Gurgoan, Ferozepur Jhirka and Nuh Tehsils, about half of which will have flow irrigation and half lift irrigation. The Project has been examined by the Central Water & Power Commission and their comments have been sent to the Chief Engineer, Punjab. The Punjab and Uttar Pradesh Governments are under correspondence with each other regarding the allocation of supplies at Okhla for the Gurgaon Canal and for the extension of the Agra Canal.

The existing Agra Canal belonging to U.P. Government serves an area of about 1.5 lac acres of Palwal Tehsil of Gurgaon district. The annual irrigation from this canal in Gurgaon district is about 62,000 acres. It is not correct to say that this canal passes through Gurgoan district without doing any irrigation.

It is understood that U.P. are also contemplating the utilization of whatever waters may be available for certain weeks during the rainy season on some of their channels also. It is also learnt that Rajasthan is contemplating to ask for a portion of these waters for irrigation in that State. It would, therefore, appear that the question of the distribution of whatever waters may be available for the short period in the Jamuna at Okhla may ultimately require inter-State discussions, a decision on which will have to precede the approval of the Gurgaon Canal Project and other Projects in U.P. or Rajasthan based on the availability of waters.

Regarding areas of Bhiwani Tehsil, extension of irrigation from the Western Jumna Canal is being done. Lately, a scheme to prodvide irrigation to about 30,000 acres of new area in Bhiwani Tehsil has been sanctioned and is under construction under the G.M.F. programme. Further schemes are also being taken up both in Bhiwani Tehsils.

Utilisation of the Cauvery Waters

The discrepancy in the figures of percentage pointed out by Shri Boovaragaswamy is being examined and the position will be expalined as soon as possible.

Details of secondhand machinery purchased for the Bhakra Nangal project

The cost of machinery purchased second-hand was Rs. 27,56,830/-; out of this, machinery worth Rs. 1,25,082/- was purchased from the D.G.S.&D., being Army Disposals. The balance of Rs. 26,31,784/- is the cost of second-hand machinery purchased in U.S.A. Details of the machinery are given in the Statement attached.

DETAILS OF USED MACHINERY PURCHASED IN U.S.A.

A. Purchase Order No. UM-3, dated 7.7.1952

Item No.	*Description.*	*Total cost (Dollars)*
1.	Cooling Tower Steel.	1,222.25
2.	Trestle Steel.	47,975.32
3.	River Brigde Steel	6,273.59
4.	Miscellaneous Steel.	4,136.85
5.	Generators—one.	2,300.00
6.	Belt Line Equipment	181,400.00
7.	Extra Belt	17,874.05
8.	Extra top idlers	3,296.95
9.	Extra bottom idlers	21.45
10.	Extra Return Train Idlers	500.00
11.	Reed Tube Turn Unit	1,479.00
12.	Ammonia compressor Unit (complete with cost of conversion of Motors and Generators).	98,100.00
		$ 364,669.46

Supplement 1

One No. Torch World Acetylene Generator.	175.00
3 Snub Pulleys 30″×35″	450.00
2 Snub-Pulleys, 20	100.00

Supplement 2

56 No. 30″ Robins S-25 5″ dia. Top Troughing Idlers	798.00
6 No. 30″ Robins S-35 5″ dia. Return Idlers.	42.90

Supplement 3.

2 No. Oxygen Manifolds	150.00
1 Flash Arrestor with 2 Grinnel Saunders 2″ valves.	
1 Flash Arrestor with 1 Brass 125 valve and 1 Hills McCanna Series 500 A valve.	70.00
Grand Total : $	366,455.36

B. Purchase Orders No. Um-4 dated 11.7.1952.

Item 1. One No. Whirley Crane	50,000.00
Item 2. One No. Charges for overhaul and changing present electrical equipment.	8,226.00
Total : $	58,226.00

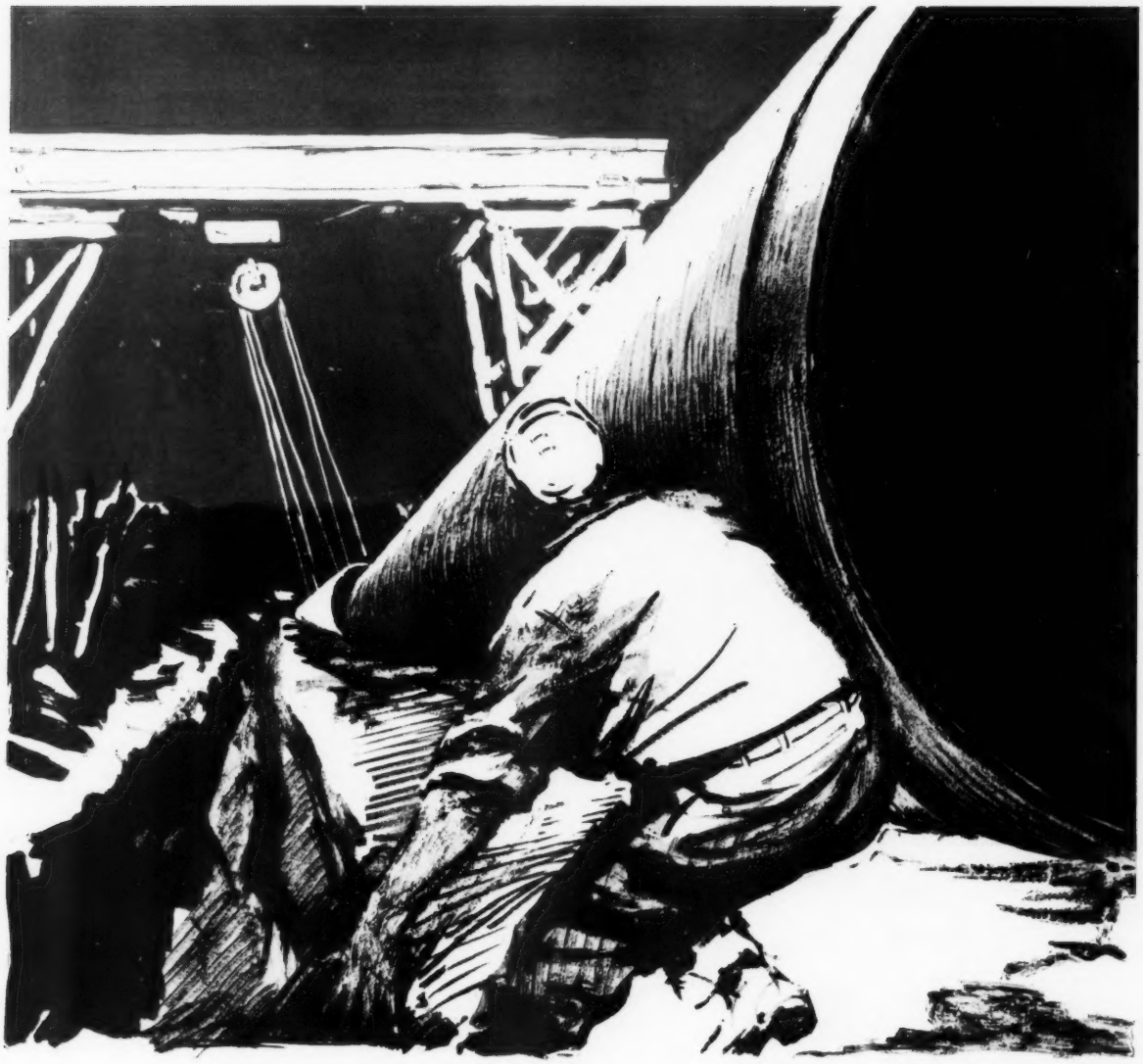
C *Purchase Order No. Um-5 dated* 11.7.1952.

(1)One No. Colby Crane.	$	35,000.00
(2) One No. Charges for overhauling and changing present electrical equipment.	$	4,625.00
Total :-	$	39,625.00
(Grand Total of all the three Purchase Orders as mentioned above).		464,306.36

Winding and Wandering of Assam Rivers

(*Continued from Page* 29)

In an article entitled "Floods from the Crumbling Himalayas" the author has stressed the need for canalising and training silt from the Himalayan rivers as an effective measure for flood control. The analysis of river behaviour outlined in the forgoing paragraphs makes it all the more clear that attempts to suppress natural tendencies of the river to elongate or to spill or both by external measures would, at best, be of a temporary nature. On the other hand, these obstructions would give rise to unstable conditions and in the long run may prove disastrous. Here again, like the floods if we could arrest indiscriminate transport of silt down the valley by inverting it on to land, it may be possible to control the river courses more effectively and thus save erosion and destruction of river banks.



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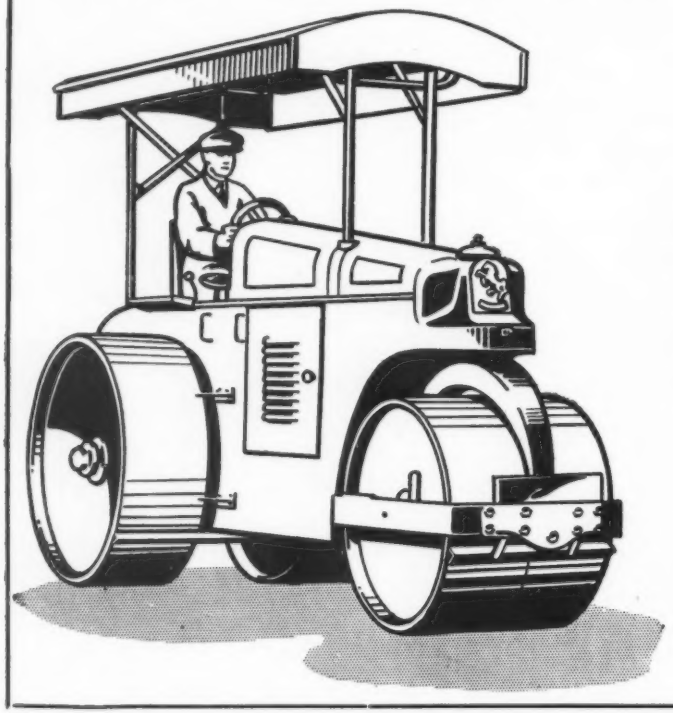

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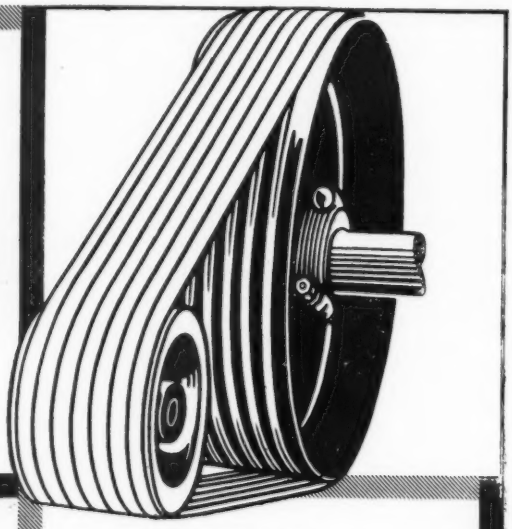

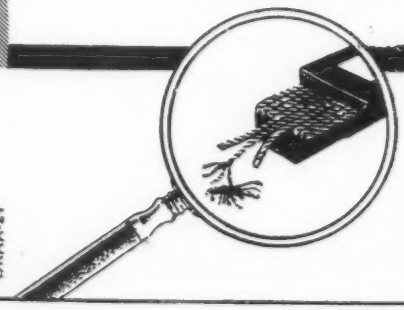

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Winding and Wandering of Assam Rivers

D. S. SINHA

AUTHOR

Assam's river problem is in some respects proving to be unique, and with the recent earthquake the problems have been considerably aggravated. Last year's floods have not yet been erazed from public memory. A closer and systematic study of Assam's rivers is being done now by some of India's senior engineers and river experts. Meanwhile here is a brief study of the winding and wandering nature of these rivers by one who has been in that part of the country for some time and has devoted considerable attention to the subject. We hope his views and approach to the problem will be studied with interest.

The behaviour of rivers in the Assam valley is a most fascinating study. If you were to fly across the mighty Brahmaputra towards North Lakhimpur or Pasighat (NEFA) you would notice its tributaries winding their way in beautiful serpentine curves before finally disappearing into the main torrent. Each of these tributaries, in turn, is joined by several smaller feeders which also have a zig-zag and meandering course. Similarly, if you were to motor down from Imphal to Dimapur through the Naga hills, you would notice, deep down into the valley, not a straight but a serpentine stream carved out into its bed to carry the drainage water from the hills.

A Winding River in Assam

Why do these streams choose such a zig-ag course and not flow straight into the main river ? The answer lies in the fact that in addition to water, these rivers carry another material—and this is the silt load washed down from the mountains.

D. S. Sinha *is Officer for Irrigation, Community Projects Administration, Govt. of India.*

For any flood discharge, the quantity of silt carried at any point of a river system depends upon the bed slope. The same factor determines the maximum size of the silt particle that could be transported. Through his well known experiments, Lacy clearly showed that for any given flood conditions and a particular size of the silt particle, a stream with a movable bed had one and only stable waterway. Under such conditions, the channel would neither silt nor scour. He used the term 'Silt Factor (f)' to define the size of the silt particle. From the above, it followed that for any given discharge and a particular silt factor, there was always a unique value of the bed slope. With such slope the channel would neither silt nor scour. Lacy's formula connecting discharge 'Q', slope 'S' and silt factor 'f' is as follows :—

$$S = \frac{1}{1788} \times \frac{f^{5/3}}{Q^{1/6}}$$

If, therefore, in a stable river system, the bed slope is increased, there will be a tendency to scour. In consequence the silt carrying capacity of the river in

The Wandering of Rivers

that particular reach would increase. On the other hand, if the bed slope flattens, the river would tend to drop its load and the bed would get silted up.

Let us now consider the effect of short-circuiting a loop in a silt-laden river.

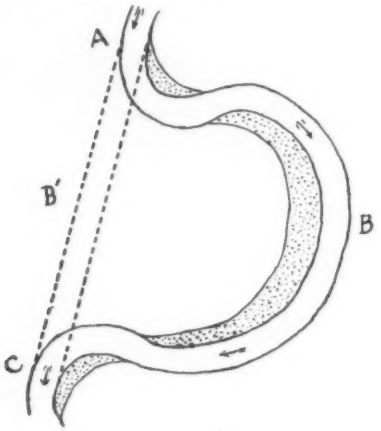

Fig. 1.

The bed slope in the short-circuited reach AB'C would be more than the stable bed grade in the original course ABC. This would result in scouring of the bed and more silt would be carried in that reach. Since the bed slope downstream of C, and in consequence its silt carrying capacity, has not changed, the excess silt coming upstream of C would get deposited. This would have resulted in the formation of a "silt wall" or a "silt weir" at C had it been possible for the "silt wall" to withstand the impact of water falling across a drop. Since this is not possible the only course, left to the river, would be to re-form the loop in some manner and get back its original gradient.

Similarly, when the incoming load of silt at any section in a river system is in excess of what could be passed through that section, the silt would start halting along its course upstream. This would naturally imply a reduction in the silt carrying capacity of the river in the above reach. If the river has high banks, it would elongate so as to have a flatter bed gradient and consequently a reduced silt carrying capacity as shown in Fig. 2.

If the banks are low, the river would spill on the banks and leave the silt load there. If the banks are not too high, it would first elongate and then spill as shown in Fig. 3.

Whether the river would spill or elongate or do both, would depend upon the exact stage at which unstable conditions are set up. Thus in the plains where the banks are comparatively low, unstable conditions do not generally occur when the river water is low because due to flat bed gradient the silt carried is comparatively much smaller. In such a case, the river does not much meander about. However, when the water level is high and the silt transported is great, unstable conditions are set up. The silt starts halting by spilling of water upon the banks and in the countryside.

In the more sloping land as in the case of Assam rivers, unstable conditions occur even at low water levels because the bed load carried is comparatively great due to the steep bed gradient. Also detention of large quantities of silt by spilling of water on banks,

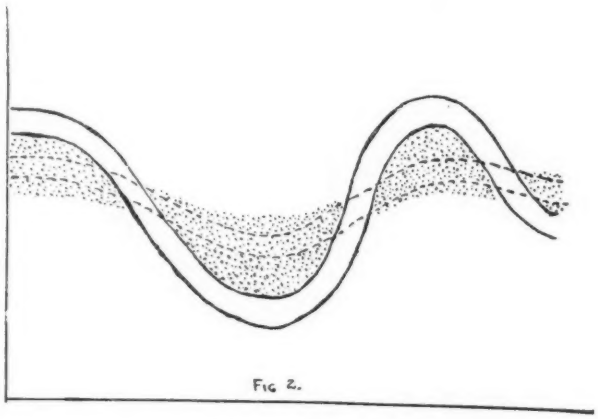

Fig. 2.

as happens in the plains, is not possible on sloping land because the area of spill is comparatively much smaller. The result is elongation of the river. If the water level goes higher than the banks, spilling also takes place in addition to elongation. If spilling and elongation both take place, the river starts wandering because when one course gets silted up, the river carves out another course by its spill and the process continues.

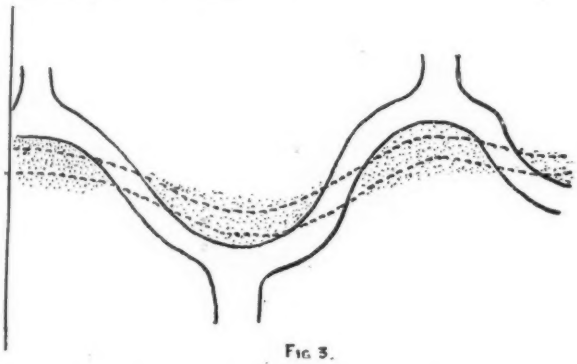

Fig. 3.

It would seem as if there is some apparent affinity between silt and water—as if when the silt starts halting, it drags water along with it. This is not so. Waters follows silt purely from hydrological considerations. When the incoming load of silt cannot carried further owing to some restrictions in the silt carrying capacity of the river system lower down, it is deposited in the way. This in turn reduces the river crossection. The inevitable result is heading of the water. In the process, the river elongates or spreads, or does both and the bed grade flattens. This continues on till the changed bed-grade gets

adapted to the changed carrying capacity of the river in respect of silt. This adaptation has to take place upstream of the obstruction throughout because at every point the silt carrying capacity of the river will have to reduce proportionately so as not to hurl excess silt lower down.

If an obstruction is put in the way of a stream with an immovable bed and carrying free water, the the behaviour will not be as above. Water will simply head up without causing a change in the river course upstream. The two cases are illustrated below :—

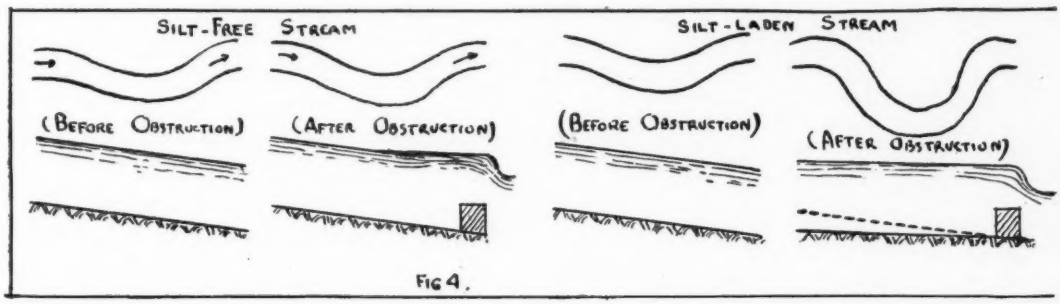

FIG 4.

All these conditions could be actually observed in the behaviour of Assam rivers. The Ranganadi beyond its junction with the Joyhing in north Lakhimpur originally followed a loop with a bed gradient of 1 in 1200. Later on, it started spilling into the township of north Lakhimpur. A year back, the loop was short-circuited by the Embankment and the Drainage Department of Assam and the river has now a bed grade of 1 in 700. Spilling of the river into north Lakhimpur has also been prevented by the construction of an embankment. The river following a loop instead of the straight course and its subsequent spilling into the countryside tended towards stability. In the opinion of the author, short-circuiting the loop and preventing its spill by construction of the embankment might give rise to unstable conditions and the arrangement, in the long run, may not be able to withstand the natural tendencies of the river.

The Dekang in this very tract used to flow some 20 years back about 15 miles west of its present course. Now, it has started spilling towards the east into the Menha river. In fact, during the last rains, it actually carved out spill channel joining it with the Menha. An embankment has recently been constructed to prevent the spill.

As you fly from Jorhat to Gauhati along the south bank of the Brahmaputra, you could see from the air, the wandering of streams at all stages. Somewhere, you would notice an old loop containing only stagnant water. This used to be the original course of the stream, which is now disconnected from the main river by silt deposit. At others, you would notice the water surface in such loops overgrown with green vegetation. Still at another place, the loops will have completely silted up and two rows of green trees are the only traces of old banks between which the river originally flowed. The Brahmaputra itself being unable to carry the silt load divides and subdivides at several places ; while some of the bigger tributaries in the process of changing their course have left utter chaos and confusion behind them. Stagnant pools of water interspersed with cultivated patches of land indicate roughly the original of course of the river.

The most interesting features of river behaviour are noticeable on the road to Dimapur in the Golaghat subdivision. This road runs at the foot of the Mikir hills and close to the banks of the Dhansiri river. It follows a zig zag alignment conforming to the winding course of the Dhansiri river. At several bends, the river has shown strong tendencies to elongate by

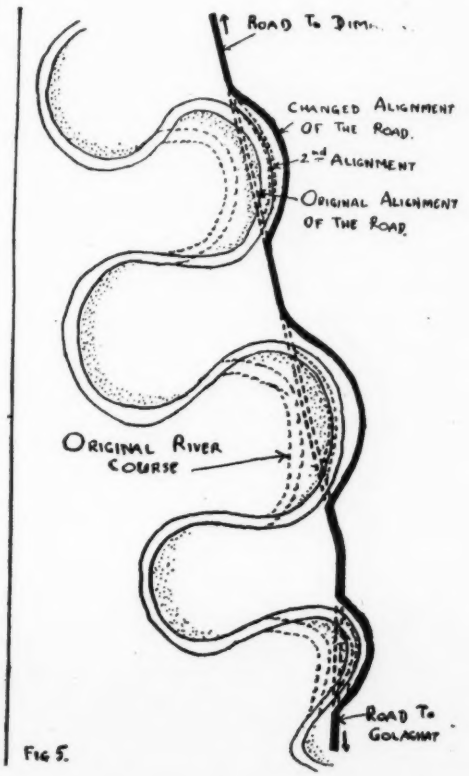

FIG 5.

erosion of the outer banks. The road is mostly tarred. The river has already eaten away several portions of the tarred road at its bend and it had to be reconstructed along more convex alignments. Later on, even these newly constructed bypasses (as one may call them) were cut away and the road had to be constructed a third time along a still more convex alignment. Many portions of the road at other bends of the river are still threatened to be washed away. The road is constructed on a strong embankment, but even this embankment has not been able to withstand river erosion.

The serpentine course of the streams deep down into the valleys of the Naga hills such as has been described earlier is a case of both elongation and spilling. The stream maintains a serpentine course to restrict the silt carrying capacity even at low water levels; side by side, the bed of the valley including the bed of the stream rises due to spilling at high water level and consequent silt deposit.

The manner in which a river elongates and how nature helps it to do so is also interesting. It is a well known fact that a channel on its outer curve has a tendency to scour and on the inside it has a tendency to silt. It is not because, as is sometimes erroneously believed, the velocity of water on the outer curve is more than that on the inner curve. When a particle is made to deviate from its rectilinear course, it must, according to the laws of dynamics, be subject to a force 'normal to its course'. The same thing happens to flowing water. When it moves in a curve, the bank on the outer side exerts a thrust normal to the flow of water. The reaction opposing this thrust has a hammering effect on the bank and in the process it erodes. The convexity of the loop increases and the river elongates. Though a bend in a river, according to the above analysis, would give rise to unstable conditions, the elongation does not take place indefinitely. As soon as the river attains the bedgrade necessary for stable transport of silt and water, further erosion on the curve and consequent elongation stops. It thus follows that elongation of river course and erosion on curves, although induced entirely from different causes, help each other.

For preventing erosion on curves, bamboo, timber or boulder spurs projecting from the banks are sometimes constructed. These, no doubt, induce silting and protect the banks against erosion to some extent but here again if the natural tendency of the river to elongate is too great, the bamboo spurs would not be able to protect the banks.

Now, suppose a loop is short-circuited without altering the natural bed gradient in the manner as shown in Fig. 6. For maintaining the natural bed slope of the original river course ABC in the short-circuited reach AC (shown dotted) there will be a sudden drop at C. If a fall were constructed at C to overcome this drop, it would serve the purpose of the loop ABC. It may

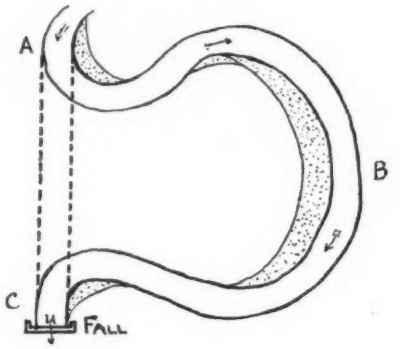

FIG 6.

thus be possible to stabilise the short-circuited course AC by constructing a fall at C. (This will have to be tested). Also, let us examine the converse proposition, that is, if a river shows tendency to elongate along the curve ABC by scouring of banks at B could it be suppressed by the construction of a fall at C. It could not be. The tendency of the river to elongate at 'B' is simultaneously transmitted to the reach A immediately above it so that the silt carrying capacity is reduced at every point upstream. By constructions of a drop wall at C, the water surface would assume the following profile :

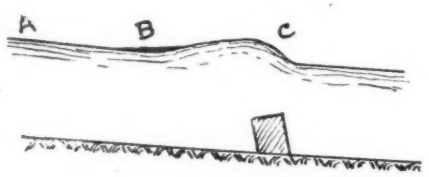

FIG 7.

Though the water slope would become flat in the reach BC and there would be consequent reduction in the silt carrying capacity, it would remain unaltered at 'A' and the silt carrying capacity here would be more than in the reach BC. This would result in unstable conditions and the river in the reach BC would start elongating still further and even spreading. But we could possibly suppress the tendency of the river to elongate at B by putting an obstruction at A because in that case, less silt would pass downstream of A. This would, however, imply creating unstable conditions upstream of A. If B were a much more important region to be protected than the reach upstream of A, the obstruction might prove to be effective.

A fixed and more definite river course downstream

of an obstruction such as a road or railway embankment would appear to suggest a possible method of controlling rivers. If at convenient places obstructions like a regulator or a boulder weir (encased between two rows of sheet piles) are introduced to act as silt traps, the river could be trained to have a more definite course lower down with much less erosion of banks. These silt traps need not be necessarily in the upper reaches of the catchment. It has been stated earlier that the behaviour of a river system at any point, i.e., its silting and consequent elongation and spilling, are conditioned not only by the incoming silt load which is an upstream factor but also by the silt load passing lower down and its silt carrying capacity in that reach.

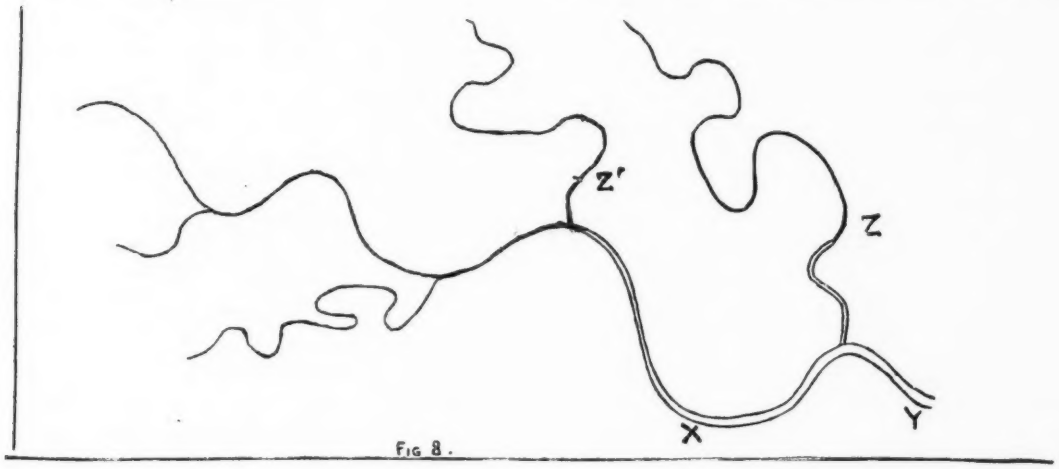

FIG 8.

Thus in the above sketch suppose the river has a tendency to elongate at X. This tendency could be checked by reducing the silt load passing at Y or in other words, a silt trap at Z would serve the purpose. A silt trap at Z' which is upstream of the section would, of course, be equally effective because it would cut down the quantity of incoming silt. It is obvious that the silt traps would cause upsetting of the river conditions upstream. Another remedy of saving B would be to short-circuit the curve without disturbing the natural bed gradient, i.e., by constructing a fall at 'C'.

All these suggestions have a special reference to the saving of towns on river banks, e.g., Dibrugarh, which is threatened to be eaten away by the Brahmaputra river. The Dimapur road itself could possibly be saved from being continuously eroded at the sharp bends of the Dhanasiri river by employing any of the above methods.

Standing on the bank of the Dihang river, you notice the greenery of the Abor hills at the foot of which this main feeder of the Brahmaputra winds its way. Amidst that greenery you would also notice blank patches. These have been caused by land slides. It is said that during the last earthquake, several of these land slides occurred. These sudden additions to river load give rise to unstable conditions resulting in elongation and severe erosion of banks.

Year after year the Dihang has been taking a heavy toll of land and buildings of the Pasighat township situated on its Southern bank. The river has cut the banks almost vertical. Giant trees completely uprooted could be seen lying on the banks in dead condition, while inmates of houses on the bank silently await the grim future of their dwellings.

In Cachar the mouths of some of the big tributaries of the Barak river have been blocked with a view to prevent back spill from the latter when it is in high floods. This back spill used to extend sometimes to miles and cause submersion of the tributary basin. With the blocking of the mouths, the silt which originally used to be detained in the tributary basin is now hurled down the main river and the effect is analogous to that of short-circuiting a loop or even occurrence of land slides. This has, in some cases, resulted in severe erosion of the river bend close to the mouth showing its tendency to elongate.

So also obstructions like road and railway embankments with inadequate water way, in their bridges upset the river equilibrium. The uniform silting of the river from year to year, however gradual it may be, makes the bed flatter and flatter and continuously keeps on changing the conditions necessary for stable flow.

The author did not have an opportunity to test the above analysis by means of experiments conducted in a laboratory. The suggestions made would thus be in the nature of a thesis based purely on a study of river behaviour. The conclusions, however, appear to be most logical and it would be interesting to carry out laboratory experiments on the behaviour of silt laden rivers under varying conditions of silt load. These results could be utilized for effective control of rivers.

(*Continued on page* 24)

Our Delhi Letter

(From our Special Correspondent)

Vital role of Irrigation and Power in the Five Year Plans and necessary precautions

The success of the First Five Year Plan is now an acknowledged fact. Since Irrigation and Power Projects formed a major portion of the programme, the country has appreciated the role of the public sector in this sphere. The effect of achievement has not been robbed of its real glory, even though there were a few dark spots in it due to non-observance of the rules of accounts in all their strictness. Even some errors or a few cases of proved corruption can not be viewed in such a warped perspective, that sense of proportion be lost and 95% good may be decried because of the 5% evil. In fact, this latter is tied up with the improvement in the country's morale all over. Meanwhile there is need for greater vigilance. The choice of the keymen at the top is particularly important.

Causes of Weakness

A lot of the laxity of control is occasioned by the fact that planning and project preparation are generally incomplete. There is room for too many alternatives even in the fundamental and broad outline. Works are therefore started on doubtful data, and departures from the initial estimate are too drastic. Their effect on the technical as well as the financial aspect is so great that the original figures are multiplied two or three fold. The confidence of the public gets badly shaken because there are always some interested persons who distort the position to get cheap fame. This has been found true of some criticism of a few engineering projects, in which engineers themselves have been in the forefront of picking out holes in the work of their own colleagues. It is possible that politicians encourage these tendencies in order to strengthen their own position. But such games may sometime jeopardise the general interest of the country.

Scrutiny of Projects

Arising out of this, there are two factors which are receiving prior-most recognition. First, that the projects in the field of Irrigation and Power should be well-conceived and sufficiently detailed, to qualify for their inclusion in the Plan. Second, that there should be an imprint of scrutiny and vetting of such projects by the topmost experts in the country. Both the above requisites can be fulfilled only if the country gives recognition to the constitution of panels of experts derived from the country's experienced engineers. Such personnel are available and only too anxious to be invited to assiociate themselves in the projects of the regions where they have acquired experience. But at present there is lack of a proper machinery, which could enlist such individuals into panels whose advice would be respected and valued.

Need for a Panel of Experts at moderate fees

The Mascarenhas Committee on personnel-planning are busy finalising their interim report. There is urgent necessity that they give a verdict in favour of constituting panels of engineering experts derived from retired and retiring Chief Engineers of States and the C.W.P.C. At present the principle of extensions and re-employment is evoking a lot of criticism, because of the doubt of favouritism and political influences which lead to such a state. The retired engineers should have a suitable retainer or fee which is commensurate with the time and labour involved in the assignments given to them. Such fee should be regarded as a symbol of honour and recognition and it should not be exorbitant.

Socialistic pattern for country's Projects

The Rihand Project contract awarded to Hindustan Construction Co of Bombay evoked a good deal of controversy as to whether it was proper in the context of the country's decision in favour of a socialistic pattern to encourage private firms to execute the country's major projects. It was however apparent that the country is not yet geared up for departmental construction of all its major projects. The personnel needed for such arrangement is much beoynd the strength of the meagre service cadres of the various states.

Parrallel Operation of Departmental and Contractual Agencies

However, a combination of the two systems will do a lot of good. Certain Projects like the Bhakra are being done departmentally and certain others like Rihand, when executed through the agency of contractors will give rise to a healthy competition and reliable yardsticks. There is no reason why with proper coordination such a course may not produce the best results, both in efficiency and economy. With the expanding programmes of construction, this is the only way of avoiding hold-up of urgent works on the one hand and their satisfactory completion on the other. Very soon conventions will be set up which will work for assured achievement by the survival of the fittest techniques, and a broadening of the present methods of contracting and execution.

Need for publicity and propaganda

Meanwhile, increasing need is felt for effective publicity of the country's projects. The plans have to be of the people, not only at the level of benefits or of execution but even when they are still in the thinking stage. For this purpose, greater vlaue needs to be attached to the service which is being rendered by the country's technical press. It is now evident that economic rather than political factors are the

deciding criteria in the formulation of policies and programmes. All our projects have therefore to be represented not as sealed books and reports (as in the past), but as vistas of rich and attractive information where the authorities should invite the people rather than keep them out. For this purpose a healthy and constructive curiosity will be aroused in the people who will understand the real yardsticks for evaluat ing any achievment and mere catch words or slogans will not sway them into unbalance.

Bhakra Project visitors see great progress

In the case of the Bhakra Project at least, this need for publicity is being recognised and achieved—thanks to the Prime Minister. By his personal interest he has directed the eye and ear of the country to be responsive to the progress that is being achieved on this project. In his recent visit there, he evaluated this great job as one that ranks amongst the biggest and toughest anywhere in the world. "Bhakra" he said "is a word of power in this country."

There is hardly an ambassardor or a Prime Minister of any foreign country who does not visit Bhakra Dam Project and its connected works. The foundation work of the main dam in the magnificent gorge, or the completed Nangal Dam and the Nangal Hydel canal or the recently commissioned Ganguwal Powerhouse all succeed in conveying to the visitors, the greatness of the scale on which this grand drama is being enacted. No wonder the people have also been influenced beyond measure because they are already reaping the partial benefits from the advance stages of construction, which have yielded kharif irrigation and the first quantum of power.

Generation of large blocks of Power

The biggest event that will influence the region of the Bhakra Nangal Project is the generation of large blocks of power at Ganguwal and Kotla on the Nangal canal, which will be followed by the giant power plant at Bhakra dam. It appears that with the assured availability of power there is an unmistakable trend for industry to take advantage of the resource. Thus the doubts that were entertained about the sale of the power produced have already been dispelled. In fact the scene is already converted into one in which grave shortages are anticipated because the production of power is not expected to keep pace with the rising demand.

The Fertiliser-cum-Heavy Water industry

The single block requirement of the fertilizer factory for 160,000 kilowatts at 95% load factor has necessitated that three of the joint 90,000 kilowatt units will be completely utilized for this item. The Punjab Govt. are understood to have offered this power at 2.6 pies per unit. This rate is considerably less than any obtaining elsewhere with a guaranteed supply of this magnitude. While on the one hand production of cheap fertilizer at Sindri rates will be ensured, there will be the added advantage of the country becoming self sufficient in atomic energy resources. There is no doubt that the financial success of the Bhakra Project will become doubly assured with the sale of such a large volume of power. The annual returns from this transaction are expected to be over Rs 1½ crores, taking into account only the firm power.

Scope for utilisation of secondary power

The capacity of the Bhakra machines will not be taken full advantage of, because of the fact that in lean years, there is not enough water to produce maximum output all the 365 days. On such occasions although the requirement of 160,000 kilowatts will be fulfilled, almost an equal amount of power available for 9 to 10 months in a year will remain unutilized. The fertilizer factory designs are being studied from the angle of utilizing such secondary power which may be offered by the Punjab Electricity Branch at a considerable discount.

Special features of India's economy

Now, that the country is embarking on other big power projects like the Koyna, Rihand, Nandi-Konda, Chambal and Kosi, it is of the highest importance that the country should make use of secondary power even though there are some difficulties in such a course. India may not attempt to carry imitation of Western economy and practices to absurd limits. With her advantage of a lot of human labour resource being available, she should evolve procedures and traditions which enable her to utilize her resources and facilities in a unique way. The question that must continuously be asked is, whether any departures from accepted practices will lead to a fuller and earlier solution of India's problems of production and employment.

Tenders for giant Hydroelectric units for Bhakra Power Plant

Tenders have been invited for six turbines each of 125000 H.P. and six generators each of 100,000 K.V.A. capacity. The bid invitations have been issued on a global basis so as to have world competition in the supply of this key equipment. Meanwhile the construction of penstocks and the foundations of the Power plant has been undertaken.

Asian Training Centre at Roorkee University

Efforts made by Shri Khosla for the setting up of an Asian Training Centre at the University of Roorkee are making headway. With the huge amount of water resources development experience available in this country, there is admirable scope for a strong nucleus for the training of engineers who have to tackle the huge task of developing the Afro-Asian regions. Whereas the borrowing of some technique from Europe and U.S.A. and Russia is unavoidable, the contribution that India can make will be of no mean order. It is understood that the Government of India Education Dept and the Senate of the Roorkee University are blessing the bold step which has also the general support of the Prime Minister.

Notes & News

THE NUCLEAR POWER PLANT CO., LTD.

A group of firms who either have had close association with the United Kingdom Atomic Energy Authority in the design and construction of the Calder Hall Atomic Power Station, or in experimental reactors for Harwell, or who have special experience and facilities for such work, are associated with a recently incorporated separate company which will concentrate on the research, design and construction of nuclear power stations.

Registered with an authorised capital of one million pounds, The Nuclear Power Plant Co. Ltd., has its registered office at Heaton Works, Newcastle upon Tyne. The design headquarters is Booths Hall, Knutsford, Cheshire.

The associated Companies are:

C. A. Parsons & Co. Ltd.,	Newcastle upon Tyne.
A. Reyrolle & Co. Ltd.,	Hebburn-on-Tyne.
Head, Wrightson & Co. Ltd.,	Thornaby-on-Tees.
Sir Robert McAlpine & Sons, Ltd.,	London.
Whessoe Limited,	Darlington.
Strachan & Henshaw Ltd.,	Bristol.
Alex. Findlay & Co. Ltd.,	Motherwell.
Clarke, Chapman & Co. Ltd.,	Gateshead-on-Tyne.

Parsons, Reyrolle, Whessoe, Strachan & Henshaw and Alex. Findlay have gained valuable experience in the development of the Calder Hall Power Station. Head Wrightson have had wide experience in the design and manufacture of modern heat exchange equipment; they have been engaged for some time in the design and construction of various types of reactors at home and abroad; they are also designing and building the large heavy water plant in New Zealand. Clarke, Chapman have wide experience in steam raising and allied equipment. McAlpines have been outstandingly successful in the Civil Engineering field, particularly in the construction of power stations for the Central Electricity Authority.

The combination of these eight firms will enable The Nuclear Power Plant Co. Ltd., to design and construct atomic power stations in any part of the world.

The Directors of N.P.P.C. are:

President and Chairman—Sir Claude Gibb, C.B.E., D.SC., F.R.S., Dr. A. T. Bowden, PH.D., M.I.MECH.E., R. Edwin McAlpine, Richard Miles, B.SC., M.I.MECH.E. Harold H. Mullens, B.SC., M.I.E.E., Arthur J. Sayers, A.M.I.E.E., Sir John Wrightson, BT., T.D.

The Secretary of the Company is—D. P. Walton, A.C.A.

The Parolle Electrical Plant Co. Ltd., (joint proprietors—Parsons Reyrolle) who have been associated with the Atomic Energy Authority in the design and construction of the Calder Hall Power Project will co-ordinate the activities of the eight co-operating companies in design and construction. They also will be responsible for site services.

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Editorial

Refresher Courses for Engineers

In the present age when new problems, fresh innovations and ever changing techniques are the order of the day, serving engineers, whatever their field of activity, must continuously brush up their knowledge and keep it to-date if they have to make an effective and worthwhile contribution towards the rapid industrialization and development of natural resources of the country.

Reference was made to the necessity of introducing Refresher Courses for the purpose, by Shri G. L. Nanda, Minister for Irrigation and Power, Government of India, in his Convocation Address to the Roorkee University, in December 1952. He said : "Refresher Courses are highly useful and absolutely necessary in view of the large number of developments that are taking place in engineering. The best way to achieve economies in project is to keep the engineers engaged on them fully acquainted with the latest developments concerning them."

The Central Board of Irrigation and Power took the initiative in the matter and the Ministry of Irrigation and Power moved the Ministry of Education to afford the necessary facilities.

With this background, it has been proposed, with effect from July 1955, to start Refresher Courses at the University of Roorkee which all serving engineers may attend at specified intervals during the course of active service. Such courses are already an essential part of training in the Indian Army Corps of Engineers.

Refresher Courses will form the basis for further specialisation and Specialist Courses in various subjects will be started in due course.

The Refresher Courses will deal with all branches of Civil, Electrical and Mechanical Engineering connected with present day and proposed schemes of development in the country and will pave the way for specialisation in selected fields.

Each course will extend over 3 months divided generally into two periods of six weeks each, one such period to be devoted to designs and the other to construction techniques, designs being taken up first. Where no clear division exists between design and construction, the distribution of lectures will be done to suit each case. Each course will be followed by visit to works.

To begin with, the courses will be taken up in rotation, in the order :—

Civil Engineering
Mechanical Engineering
Civil Engineering
Electrical Engineering

When the courses are established, different sets of courses and courses of different branches may run concurrently. Four sets of courses will be run during each financial year.

The courses will be specially designed to suit the needs of engineers both below and above the executive rank. There will be separate courses of lectures for officers of (*a*) Executive and lower rank, and (*b*) Administrative rank. In the courses for administrative officers, emphasis will be laid on planning, organisation and administration ; cost accounting, economics and human relations will receive special attention.

Lecturers will be drawn from the Central and States Government Engineering Departments, Universities, Engineering Colleges, Manufacturing, Contracting and Consulting Firms and Specialists from abroad. Only such persons will be invited who have been actively and intimately in touch with the subject of the lecture.

The first set of lectures will be drawn from the Central Water and Power Commission, the Bhakra Dam Project, the Damodar Valley Corporation, the Hirakud Dam Project, and the Rihand Dam Project.

In addition to the casual lectures drawn from outside sources, there will be a regular staff in the University who will themselves deliver lectures in Refresher Courses and at the same time be responsible for the programming and prosecution of these courses in their respective departments.

An engineer must have put in at least 2 but preferably 4 years service before coming to attend Refresher Courses.

Serving Officers (including University teachers) should be required to attend Refresher Courses of 3 months' duration (if necessary, in parts) once every five or six years and in any case once before promotion to the Executive grade and again before promotion to the Administrative grade.

A certificate of attendance and report on the work of each officer during the course together with a general assessment of his performance will be sent by the University to the Government or other appropriate authority for information and record in appropriate file.

Each serving officer will pay an admission fee of Rs. 50 and an additional fee of Rs. 75 per month. Thus a course of 3 months will cost each officer Rs. 275-. An officer may take more than one course at a time or in sequence by paying the admission fee only once.

The first set of courses will be in Civil Engineering and will deal with Water Resources Development—Storage Dams. The next courses in Civil, Electrical and Mechanical Engineering are being planned. The subjects for the first series will be :

General principles of Basin-wide Development.
Social Aspects.
Necessity for storage : Flood Control ; Irrigation ; Water-Power ; Navigation ; Fish culture ; Wild life ; Recreation ; etc.
Economics of Storage.
Malaria Control.
Control of Pollution of Streams.
Hydrology ; Rainfall—Run off ; Estimation of Floods and Spillway Capacity.
Catchment Conservation ; Silting of Reservoirs.

Location of Dam Site :
Topographical Surveys ;
Geological Surveys.

Dams on Permeable Foundations.
Dams on Rock Foundations.
Earth Dams.
Masonry Dams
Design Features : Spillways ; Gates ; Trashracks ; Penstocks ; Tunnels ; Dissipation of Energy ; etc.

Materials of Construction : Soils ; Stone ; Cements ; Metals ; Timber ; Stores.
Design of Concrete Mixes, Soil Material, etc.
Foundation Exploration.
Construction Planning.
Construction Preliminaries : Railways ; Roads ; including Muck Roads ; Residential Buildings ; Workmen's Colonies ; Workshops ; Stores ; Offices ; Sanitation and Water Supply ; Construction Power.
Construction Machinery : Types ; Operation ; Maintenance.
Foundation Treatment : Drilling ; Grouting.
River Diversion.
Rock Moving.
Concreting ; Form Work ; Mix control ; Inspection, etc.

Instrumentation.
Cost Analysis ; Cost Accounting.
Under-Water Work ; Pumping ; Special Precautions.
Role of Machine and Manual Labour in Balanced Planning.
Resettlement of Displaced Persons from Reservoir Area.
Water Power Studies and Power Generation.

The above list is illustrative and not exhaustive.

Irrigation and Irrigation works, flood control, seepage and surface drains and related works will form a second series of lectures ; Highways, Railways etc., subsequent series.

For detailed information the University of Roorkee should be contacted.

We on our part congratulate the University for organising this much-needed course and hope that all concerned will extend to it their fullest cooperation.

Letter to the Editor

DEAR SIR,

I have read the editorial in the March issue of your journal with great interest. Not being a scientist I tried to probe into the reasons of the unprecedented and extensive floods of last year as far as lies in the powr of a layman. I, however, never said, "It was perhaps an inscrutable act of God". I give below an extract from my speech in this connection :—

"... One is almost tempted to say that man's powers to wrest from Nature are limited. ..... Another striking feature of the current floods is that there has been a series of floods at about the same time in areas as widely separated as Switzerland and Tibet. To the lay mind it almost seems that the causes are deeply geological, or even extraterrestrial".

You seem to hold now that this is due to "interception of solar radiation by nuclear explosions".

This being interplanetary perhaps is an extraterrestrial phenomenon, although brought about by human indiscretion.

Yours faithfully,
PRAFULLA CHNDRA SEN
Minister, Food, Relief & Supplies
Govt. of West Bengal

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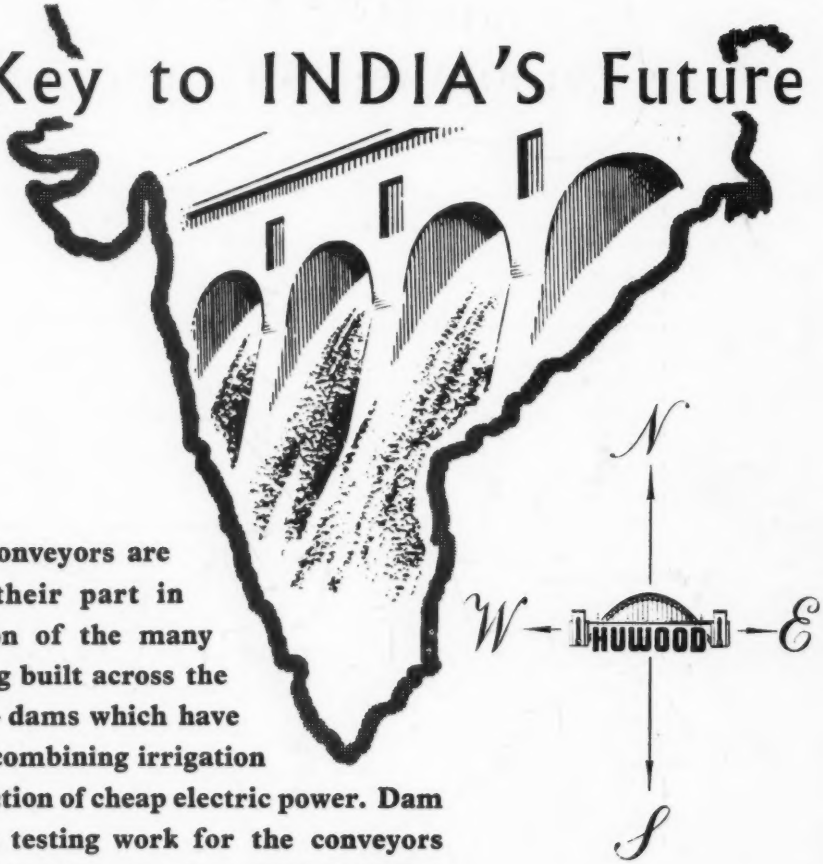

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